

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

JANUARY 23, 1989

THE BIG CHILL

How Japan's strategy may freeze the U.S. out of the superconductivity game **PAGE 24**

India's expanding solar system **PAGE 46**

India's iron-fist invitation **PAGE 58**

Fujio Saito,
NEC Corp. vice president

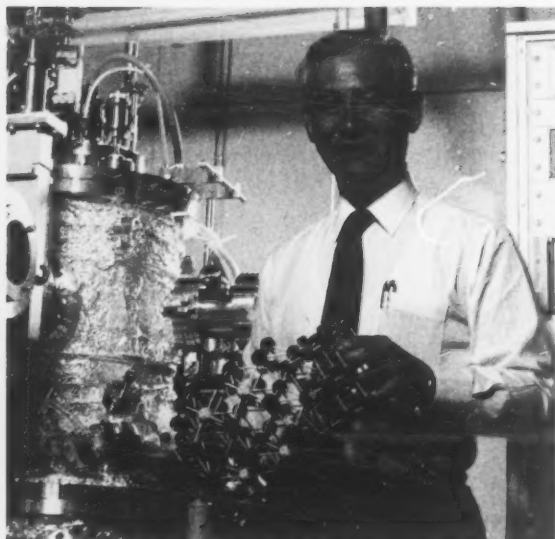


Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES — WORLDWIDE

VOL. 15, NO. 2

JANUARY 23, 1989



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There is less and less question that Japan is ahead in superconductivity. The Japanese are outrunning the U.S. in terms of technology gains, applications focus and resource allocation. While most of the world focuses exclusively on high-temperature superconducting materials developed over the past two years, the Japanese are covering all possible bases in their superconductivity research. And, with a technology that could revolutionize a number of electronics fields at stake, might American companies be caught sitting on the sidelines?

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EDITORIAL STAFF

Publisher: Frank J. Burge

Editor: John Kerr

Managing Editor: Beth Karlin

Senior Editors: Alden M. Hayashi
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Stallmann (Financial), Anne Knowles,
Bruce C. P. Rayner, Valerie Rice

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Furst (China)

Managing Editor Production: Roger C. Plant

Production Editor: Linda S. Cohen

Assistant Production Editor: Karen J. Covey

ART STAFF

Art Director: Bill Cooke

Staff Artist: Christina Rutter

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, Mass.
02158 (617) 964-3030 Telex: 94 0573 CPC
BSN 6502502256 MCI Fax: 617-964-5490

San Jose, Calif.: Valerie Rice, John McCreadie
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, Calif. 95128 (408) 296-0868

Irvine, Calif.: Bruce C. P. Rayner
18818 Teller Avenue, Suite 170
Irvine, Calif. 92715 (714) 851-9422

Northwest: Paula Doe
5011 133rd Place SE
Bellevue, Wash. 98006 (206) 641-0903

PRODUCTION

VP Production: Wayne Hulitzky

Director of Production/Manufacturing:
John R. Sanders

Production Supervisor: Bill Tomaselli

Production Manager: Betsy Harkins;
(617) 964-3030

CIRCULATION

Group Circulation Manager: Eric Schmiere
Assistant Circulation Manager: William Lazo
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U.S. out in the cold?

Superconductivity is the next great frontier for electronics companies. Not surprisingly, therefore, scientists around the world are racing to develop applications and get to market first. And the Japanese appear to be winning. "All the indications are that Japanese resolve in superconductivity is outrunning that of the U.S.," says the Council on Superconductivity for American Competitiveness.

Indeed, the Japanese are poised to freeze out their competitors — in applications, though, not necessarily in research. Because while most of the world focuses on recently developed high-temperature superconductors — ones that, it is hoped, will work at room temperatures — the Japanese are also targeting well established low-temperature materials and processes.

Japanese officials figure that once the high-temperature ceramics come on stream, it will be easy to replace the old materials with the new ones. Meanwhile, they reason that by continuing to develop the established cool products, they can focus on shorter-term applications rather than pure research. ELECTRONIC BUSINESS sent David Gumpert, editor and publisher of "The Cambridge Report on Superconductivity," on special assignment to Japan for a look at superconductor research there. In this issue's cover story, he analyzes the race and projects the winners.

Sun's solar system

Since Sun Microsystems Inc. first rose in the sky, hundreds of VARs, OEMs, suppliers and partners have swung into synchronous orbit. Business — for both the workstation maker and its satellites — has been



Assistant editor Tony Greene

good. But are there risks? Associate editor Rick Whiting details the star-studded galaxy of Sun followers and wonders if, like Icarus, whose wings melted when he flew too close to the sun, third-party companies may get burned by getting too close to this newly created Sun.

Meet Tony Greene

Although many of you manufacturing readers have already fielded his piercing interviews over the phone, our assistant editor Tony Greene hasn't quite met all of you in his half-year here. The thousands he met at Autofact and ITC know what he looks like; for the rest of you, that's him in the picture. In this issue, Tony explores two topics: the difficulty incurred in testing ASIC products and the increasing importance of high style in computer design.

BETH KARLIN, managing editor

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VBPA ARP

Media makers escape the disk drive fallout

Makers of disk platters switched early to hot growth products. But now they may be building problems of their own

Despite the difficulties some of their major customers have been having lately, most disk media executives can be seen sitting at their desks wearing generous smiles. With laggard sales of conventional disk drives staring them in the face, they knew it could have been worse.

Indeed, that's the way it seemed. When disk-media supplier Xidex Corp., the major supplier of rigid-oxide platters to Seagate Technology, closed its Irvine, Calif., plant, it laid off over 800 employees and followed that with pink slips for another 395 at its Santa Clara facility. At first glance, it looked as if Seagate's high-visibility troubles had prompted the shutdown.

Additionally, stocks of disk-media firms plunged in synch with Seagate's slide on Wall Street. And late last year, several media makers found themselves working overtime to get paid by some cash-strapped drive makers. All this for an industry that is stretching its capital to build more manufacturing plants both at home and abroad — an industry whose process technology and capital-equip-

ment needs have more in common with chip makers than with disk-drive builders.

Despite a slight overall decline in disk-platter orders in the second half of 1988, media manufacturers have fared pretty well. Most are showing enough savvy to shift away from no-growth 5.25-inch disks and are concentrating more on better-selling 3.5-inch media. According to the Santa Clara Consulting Group, a market researcher that tracks the disk-media industry, media makers this year will ship almost as many 3.5-inch platters as 5.25-inch types — 27.6 million versus 29.5 million. Two years ago, the ratio was almost 2.5-to-1 in favor of shipments of the larger units; by 1992, it will be almost 1-to-2.

This switchover mirrors the move toward the smaller drives. Researcher Disk/Trend Inc. reports that this year, for the first time, drive makers will ship more 3.5-inch units than 5.25-inch models — 7.8 million units, compared with 4.8 million.

Consequently, most media suppliers are predicting solid growth by as much as 50% this year; one firm,

Komag Inc., expects to finish the year with sales of up to \$90 million, twice its 1987 levels. For the market as a whole, the Santa Clara Consulting Group predicts growth from \$600 million in 1988 to \$1 billion by 1992 in worldwide 3.5- and 5.25-inch disk platters.

Growing like weeds

Manufacturers report that thin-film media products remain very much in demand, albeit less than was expected prior to Seagate's stunning announcement that it had lost \$52.8 million during its September quarter. "[Media] unit volumes are growing like weeds," says analyst David Velante, director of storage research for International Data Corp. In 1988, over 18 million thin-film disks were manufactured worldwide for the merchant market, twice the number manufactured in 1987, according to Dave Pearce, president and CEO of Domain Technology Inc.

Domain, second only to Seagate in thin-film media production, made 1.8 million platters during its September quarter, up 17% from the previous quarter. Pearce expects to show a modest increase in the December quarter, to about 2 million, a slowdown from the 2.2 million expected.

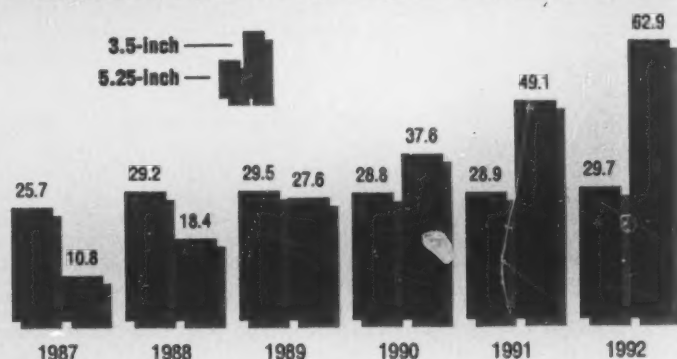
What's buffering media makers from feeling a greater impact of the sagging sales of a few drive makers is a shift in the industry's product mix. Demand is up for 3.5-inch disks and down for 5.25-inch disks, a tran-



Komag marketing vice president Hunt Payne: "Our business will return to being only good"

Rigid-drive disk media shipments

Worldwide unit shipments of all types of rigid-disk drive platters (millions)



Source: Santa Clara Consulting Group

sition that gives component vendors a broader customer base and offsets the overall decline in orders. "The imbalance in supply and demand is less noticeable with components makers," says Komag's vice president for sales and marketing, Hunt Payne. "Media people are pretty close to being in balance."

However, problems hounding the disk drive industry have touched, if not troubled, the media sector. Last November, Komag suspended shipments of sputtered thin-film disks to MiniScribe Corp. for two weeks because the drive maker was late paying for materials. Domain also reported late payments from the Longmont, Colo., drive maker. Komag had similar problems with Micropolis Corp. of Chatsworth, Calif.

Industry observers cite as a normal phenomenon the stretch in credit periods toward 90 days, from the generally acceptable 30 to 45 days, when the drive makers are hurting for cash.

More alarming were the shivers sent through the industry last summer when giant Seagate, which still makes 34% of the world's disk drives, slashed production by a third after borrowing \$290 million to expand its manufacturing facilities. Seagate later laid off more than 1,000 employees, nearly 25% of its national workforce. As a result of Seagate's misforecasting of demand, drive manufacturers are now seeing price-cutting efforts by the company to eliminate the \$318 million worth of inventory that industry analysts say

it still had at the end of the year.

However, other drive manufacturers also reported disappointing sales during the second half of 1988, which translated into slower orders for media manufacturers. Maxtor Corp. reported a slight decline in its net earnings at the end of September, down to \$1.1 million, compared with the \$2.0 million profit posted in the previous quarter. Micropolis declared a more substantial net loss of \$12.6 million at the end of September.

The problems brought precipita-

Most media suppliers are predicting as much as 50% growth this year

tion in financial circles: Domain reports that its stock was trading at \$8.50 last August, but fell to a low of \$4.50, a \$30 million drop in value, at the time Seagate's bad September quarter went public. "Even though we reported a strong quarter, we were guilty by association," says Pearce.

And while Seagate probably was not solely to blame for the Xidex plant closures — insiders say the shift from oxide to higher information density thin-film media would eventually have caused the plant to close anyway — the view is that the closure was accelerated by Seagate's troubles.

Other media suppliers have fared much better. "We've seen a slowdown in our business because of inventory corrections in the disk drive industry," says Domain's Pearce. Other media companies report similar downturns, but all remain highly optimistic that they will enjoy a steady growth rate into the 1990s.

Even though new orders have not met the expectations of the media manufacturers, companies are quick to note business is much stronger than it was in 1987. "We think our growth rate will be reduced in 1989; it will return to being only good," says Komag's Payne.

To help fuel that strong growth, media makers are pulling out all the stops to build new facilities. Domain has completed a new \$10 million manufacturing plant in Milpitas, Calif., due to be on-line in April. Financed through equity loans, the new high-speed sputtering system will give Domain a production capacity of 1 million disks per month.

In addition, Domain is also increasing manufacturing in its Singapore facility, while Komag is eyeing the country as a possible site for its first overseas factory. Komag is also investing about \$30 million in a new plant in San Jose, due to open later this year. The new factory, with a capacity of over 500,000 disks a month, is being financed through a combination of sources including \$28 million remaining from the company's IPO in May 1987.

But analysts warn that new production facilities could set the stage for an intensive price war as a result of factory overcapacity. "Our impression is we're going to be up to our knees in thin-film media by the end of the year," according to Phil Devin, an industry analyst for Dataquest Inc. If companies expand as planned, worldwide capacity could go as high as 100 million units by the end of 1989, according to Mark Geenen, industry analyst at Santa Clara Consulting Group. In addition to that, if demand estimates of 50 million units in 1989 ring true, capacity for their film disk platters will be two times higher than demand, according to Geenen. If that should happen, a price war is the logical result, and smaller media companies would be hit the hardest, according to some analysts.

JOHN MCCREADIE

Japan's allocations of money and manpower to superconductivity research could freeze the U.S. out of the race for applications

The Big Chill

BY DAVID E. GUMPERT

In a small lab in NEC Corp.'s central research facility on the outskirts of Tokyo, Hitoshi Igarashi, a senior research manager, is showing off a superconducting thin-film device. The film, composed of a ceramic — one of the recently emerged family of materials that superconducts at 120° Kelvin (-153°C) — is only 0.03 microns thick and is nearly imperceptible. "It is so thin, it looks transparent," Igarashi marvels.

The thin-film-based device is the forerunner of a superconducting computer chip or measurement device. Unfortunately, it's the forerunner by three or more years of a commercially useful device. "Much work remains to be done," admits Fujio Saito, an NEC vice president.

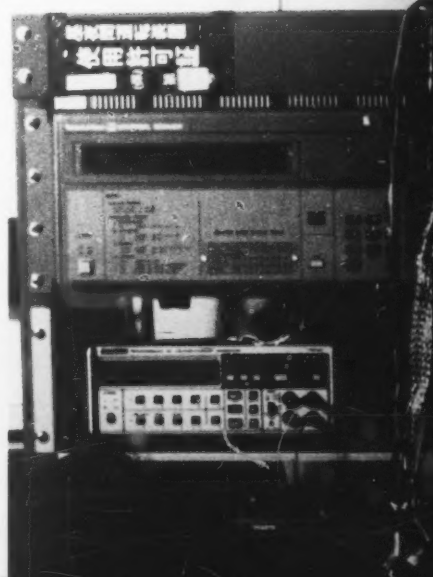
But NEC officials aren't at all concerned about the lengthy time horizon. Because, down the hall sits another lab, in the corner of which is a clear plastic box nearly filled with tiny chip-like devices. Unlike ordinary chips, though, these use niobium titanate on an aluminum-oxide base. At liquid helium temperatures approaching absolute zero, each chip employs a Josephson junction superconducting transmission device to become the basis of a computer with 1 kilobit of random-access memory.

These chips are the result of 10 years' work at NEC using the long-existing low-temperature superconducting technology. Over the next year or two, it will get its own packaging, architecture, and cooling system and become a complete large-scale integrated circuit. At that stage, it will be a strong candidate to be the basis of an NEC supercomputer.

The NEC research approach illustrates an important reason for Japan's emergence as the world's leader in superconductivity. As evidenced at the International Superconductor Applications Convention two weeks ago in San Francisco, most of the rest of the world focuses exclusively on the materials developed over the past two years — the copper oxides commonly referred to as high-temperature superconductors. But the Japanese are covering all possible bases by also targeting well-established low-temperature superconductivity.

Hedging bets

This hedging of bets will likely enable the Japanese to be first with superconductor-based products in the electronics marketplace, and that's important because electronics products will probably be the first to put commercial volume behind superconductivity. In addition, the Japa-



Fujio Saito, an NEC vice president: Over the next few years, NEC execs hope a superconducting chip will become the basis for an NEC supercomputer

Superconductivity's share of U.S. government R&D spending

nese are concentrating on transportation and power transmission applications.

There is less and less question that Japan is ahead — in terms of technology gains, applications focus and resource allocation. "All the indications are that Japanese resolve in superconductivity is outrunning that of the U.S.," says a recent progress report on policy analysis from the Council on Superconductivity for American Competitiveness (CSAC) a Washington, D.C.-based trade group of U.S. companies involved in superconductivity developments. "Our industrial competitors will inexorably ensure that the window of opportunity will not remain open forever," chides the report.

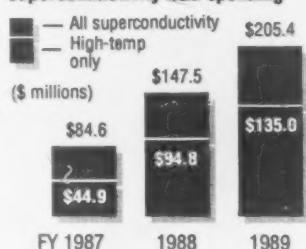
The CSAC argues that the federal government has not adopted any kind of active overall policy, despite introduction of an 11-point recommendations plan by the Reagan administration in July 1987. Instead, says the group, many of those 11 points have barely been winked at; while some federal monies have been redirected from other R&D programs to superconductivity research, and patent approvals have been sped up, antitrust rulings on joint R&D ventures have not been relaxed and top policy-making roles have been slow to be designated.

In a step toward a federal policy, however, President Reagan signed legislation last November to establish

Total R&D spending (\$ billions)

FY 1987	1988	1989
\$55.255	\$58.152	\$60.323

Superconductivity R&D spending



Figures include military research

Source: U.S. government report: "Federal Research Programs in Superconductivity"

a program to speed superconductivity R&D. The legislation requires that the Office of Science and Technology Policy establish a five-year plan for R&D in the field. Although published reports say the government has stepped up total funding on superconductivity — from \$84.6 million in fiscal 1987 to more than \$147.5 million in the current fiscal year — the plan recommends new funding and includes proposals for private sector and academic participation in R&D projects.

Why worry?

But why should U.S. electronics executives worry?

It might be easy to rationalize the

Japanese lead in superconductivity as "just one more area" in which the United States is failing to compete aggressively. Unfortunately, superconductivity isn't "just one more area." Supremacy in superconductivity may well mean supremacy in many aspects of electronics, ranging from computers to sensors to miniature antennas to millimeter waves.

The disk drive maker with the first frictionless spindle bearings courtesy of superconducting materials stands the best chance of reducing data seek and access times to unheard-of levels. The computer maker that first employs superconductive wire in board-level interconnects can boast blazing operating speeds. And semiconductor firms surely have a strategic stake in experimental superconductive 4-bit microprocessors that have been clocked at 770 MHz.

Because superconductivity confers so many advantages in terms of speed, energy consumption, size and other factors, it could quickly revolutionize a number of electronics fields. What is now required — and what U.S. firms could collaborate on — is for a number of technical and fabricating problems to be solved and for the economic advantages of using superconducting technology to be proven.

In the truest American tradition, numerous start-ups have set off to commercialize superconductivity developments — companies like

The paper chase: Japan's patent blitz

Japanese companies and government agencies are leaving no stone unturned in their effort to control the emerging superconductivity industry.

The most recent evidence for this view comes from European patent offices. In Britain and West Germany, patent applications are made public 18 months after filing; in the U.S., applications are secret until patents are awarded, which can be two or three years after filing.

Because many of the initial patent applications were filed in January 1987, when the first high-temperature superconducting materials were being developed, the public is getting its first glimpse into the proprietary side of super-

conductivity. Of 75 superconductivity patent applications examined by "The Cambridge Report on Superconductivity" that had been made public in Britain and West Germany, the scorecard as to country of origin shows that Japan fielded 59 to the United States' 10.

Of the 59 Japanese patent applications, more than half come from three companies: Sumitomo Electric Industries, Mitsubishi Heavy Industries Ltd. and Hitachi Ltd.

Among the American patent applications are some very significant ones, including two for the original yttrium-barium-copper oxide compound that started the superconductivity gold rush — one for the University of Houston on behalf of

researcher Paul Chu and one from IBM on behalf of pioneering scientists Georg Bednorz and Alex Müller. The other American patent applications come from such companies as General Electric Co. and General Dynamics Corp., along with government agencies such as the Department of Energy and the Defense Department.

The most significant of the applications appear to relate to superconducting wire and transistors. For instance, several of the Sumitomo applications cover high-temperature superconducting wire made by packing and drawing 1-2-3 material in a metal pipe. Both NEC and Hitachi have applications for transistor-type devices. □

MANAGING RESOURCES

R&D

American Superconductor Corp. of Cambridge, Mass., Superconductive Components Inc., of Columbus, Ohio, and Superconductor Technologies Inc., of Santa Barbara, Calif. But there are doubts that these newcomers have the critical mass and critical funds to push the frontiers far enough, and concern that the U.S. companies that do have the resources are sitting on the sidelines, monitoring international activity. The feeling at many U.S. companies is that once the technology is further along, they'll plunge in and quickly play catch-up. "If things really break, we'll commit to it" is typical of the defense put up.

Body of knowledge

Unfortunately, that may not be possible. As with a number of very complex technologies, superconductivity requires a body of knowledge that can't be picked up on the run. The high-temperature superconducting materials are ceramic oxides that are extremely difficult to fabricate, as researchers around the world, including those in Japan, are rapidly discovering. Because of the difficulties associated with turning the materials into commercial products, all companies involved in superconductivity have lengthened their time horizons some, seeing more applications occurring within five to 10 years rather than two to five years, as some had hoped.

Japan's applications push has plenty of justification. "The Japanese are right in presuming that everything we need for applications is already out there," says Richard Rhodenz, manager of General Electric Co.'s superconductor applications program in Schenectady, N.Y., who recently toured Japanese superconductivity facilities. "I don't think the technology depends on high-temperature superconductivity, except for certain areas of electronics."

GE is active in both the low- and high-temperature research areas. It has been able to establish a dominant position in the major commercial application for superconductivity until now — magnetic resonance imaging (MRI) equipment used for medical diagnostics. Researchers estimate that GE has up to 50% or more of the world's nearly \$1 billion MRI equipment market. Toshiba Corp. has just begun marketing its own line of MRI machines.

MATERIALS

- CERAMICS
- HIGH TEMPERATURE

CHARACTERISTICS

- ZERO RESISTANCE
- MEISSNER EFFECT
- JOSEPHSON EFFECT

APPLICATIONS TO ELECTRONICS

- JOSEPHSON EFFECT DEVICES
- SUPERCONDUCTING TRANSISTORS
- SQUID SENSORS
- VLSI WIRING
- MAGNETIC SHIELDING



Hitoshi Igarashi, NEC senior research manager: "Much work remains to be done" in superconductivity

Given the paucity of applications for either low- or high-temperature superconductivity, how can one be so sure that the Japanese are ahead? By comparing the American and Japanese efforts on three levels, including technical advances, resource commitment and planned applications. This comparison is based on extensive conversations with American and Japanese officials involved in superconductivity, as well as a recent tour of Japanese superconductivity facilities.

Technical advances. The major challenge associated with making superconductivity widely applicable in electronics is in fabricating the high-temperature materials, which are essentially ceramics, so that they can be easily produced. They also must be able to carry currents necessary for common applications. In the area of wire for motors, the minimum acceptable current-carrying capacity is thought to be 10,000 amperes per square centimeter (A/sq. cm.) in a high-magnetic field. For thin films, the capacity must be significantly higher.

One American company — AT&T — exceeded that figure months ago

in 1-cm. pieces that handled 17,000 A/sq. cm. In a one-tesla field, though, current goes down to 4,000 A/sq. cm. Other American companies are struggling to get beyond a few hundred A/sq. cm. A handful of Japanese companies are rapidly approaching the 10,000 A/sq. cm. figure with and without magnetic fields, and are confident of going far beyond it very shortly.

One of the most successful Japanese companies involved in making such wire appears to be Hitachi Ltd. The company has achieved critical currents of 6,700 A/sq. cm. in a superconducting copper oxide, based on thallium, and expects the number to keep rising. "We are going to develop thallium wire that is more than 10,000 A/sq. cm." by early 1989, says Toshimi Matsumoto, senior researcher in Hitachi's Tokyo research lab.

That current will be achieved without the presence of a magnetic field, but, based on preliminary work, Matsumoto is confident that Hitachi will quickly raise currents with the introduction of magnetic fields.

Hitachi uses a drawing, rolling method to make its wire, reducing its

MANAGING RESOURCES

R&D

must each put up over \$800,000 to join.

On the other hand, an exhaustive survey of American companies in superconductivity conducted by the OTA found 55 American companies spending about \$97 million and involving about 625 scientists and technicians at work on superconductivity R&D in 1988. Clearly, the resource commitment is less than that in Japan.

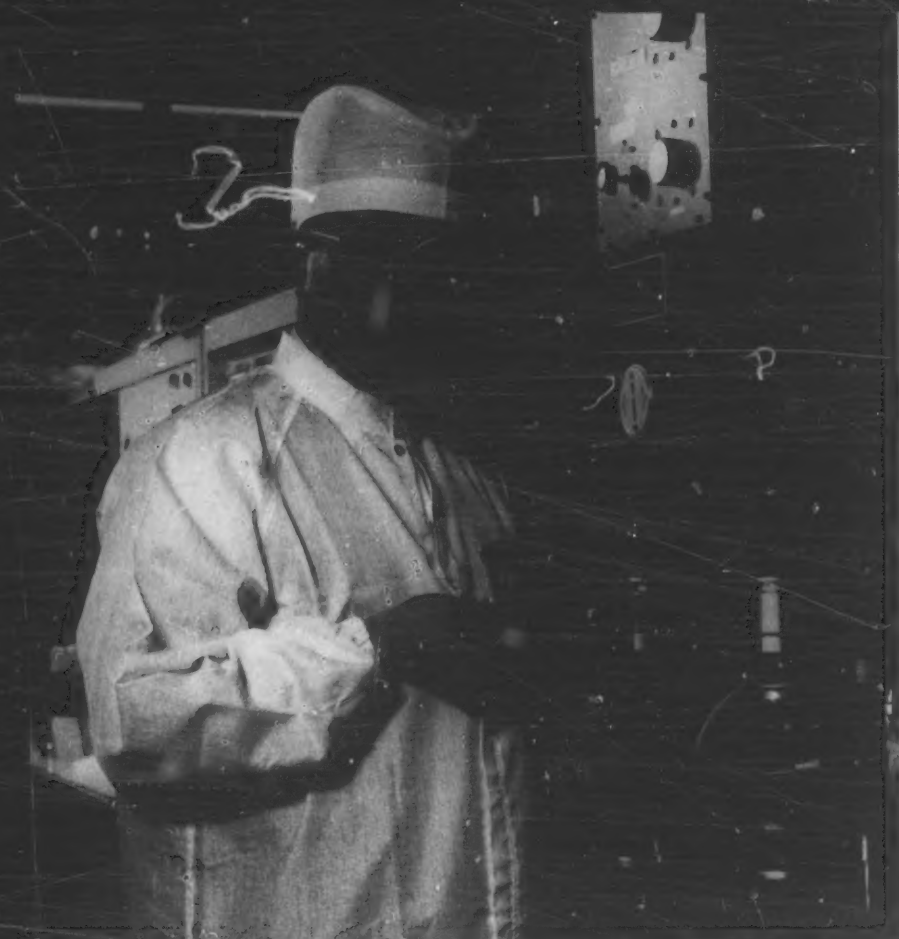
A comparison of individual companies indicates the scope of the differences. An official of Sumitomo Electric, one of Japan's most aggressive companies in superconductivity, says that company has more than 80 researchers and technicians involved in developing the technology. A more typical effort, such as that at NEC, involves between 30 and 40 people. In the United States, by contrast, the largest efforts, such as those at AT&T and E.I. du Pont de Nemours & Co., are understood to involve up to 40 people each.

The OTA concluded in its report, issued last June: "The Japanese have committed funds, not only to research, but to evaluate prospective applications. Executives there see [high-temperature superconductivity] as a vehicle for creating new businesses, while Americans are more likely to view it in terms of existing lines of business."

Greenhouse effect

Why are the Japanese more willing than American companies to commit resources to superconductivity? The answer seems to lie in their larger view of the world and their expectation that, even if they can't justify superconductivity in today's cost and market analyses, they will be able to justify it in the future. They are betting that such trends as the depletion of energy supplies, the "greenhouse effect," and growing demand for electricity will combine to make superconductivity increasingly attractive in the future. As the OTA report put it, "The Japanese seem confident that investments now will pay off — some time and in some way."

Moreover, the Japanese obsession with superconductivity is creating competitive pressures among companies to commit substantially to this new field. "The main reason we are doing research in superconductivity is because so many other Japanese



Hiroyuki Abe, NEC research manager: NEC has spent 10 years researching low-temperature superconducting technology

diameter from 6mm to 2.8mm and its thickness from 0.5mm to 0.06mm in a tape-shaped wire that is as yet not flexible. The brittleness of today's superconducting materials is one barrier to commercialization.

Another Japanese company, Mitsubishi Heavy Industries Ltd., says it has developed an approach for processing bismuth-based high-temperature superconducting materials into filaments, 1,000 of which can be used to fabricate multicore wires. While the current capacity of the multicore wire hasn't yet been determined, each filament has a current density of as much as 1,100 A/sq. cm.

Sumitomo's successes

In the area of thin films using high-temperature superconducting materials, American companies have been extremely reluctant to disclose their technical advances. But at least one Japanese company has been more forthcoming. Sumitomo Electric says it has achieved 3.5 million A/sq. cm. using a high-temperature superconducting material.

Resource commitment. At first glance, it appears that the United States and Japan are devoting nearly

the same resources to superconductivity supremacy — somewhat more than \$200 million each in government and industry spending, according to a lengthy study from the Congressional Office of Technology Assessment (OTA) issued last year. But behind that figure are some important differences.

One has to do with the level of resources Japanese companies are committing to the development effort, versus American companies. The National Science Foundation's Tokyo office surveyed 38 Japanese companies significantly involved in superconductivity and found that they expected to spend \$90 million in 1988 on such R&D. These companies have about 900 scientists and technicians at work on superconductivity. Significantly, this survey didn't include at least 21 other Japanese companies known to be heavily involved in superconductivity research; their inclusion would have raised the spending and manpower figures significantly.

Those 21 — like the other 20-odd members of International Superconductivity Technology Center, a consortium backed by Japan's Ministry of International Trade and Industry,

MANAGING RESOURCES

R&D

companies are working in it," according to a remarkably candid Nobuo Hashizume, a deputy general manager at Sharp Corp.'s central research laboratories.

Applications focus. As noted earlier, Japanese corporations are so concerned with developing applications that they are committing substantial resources to low-temperature superconductivity, which doesn't have the fabrication/critical-current problems of high-temperature materials. In Tsukuba, just north of Tokyo, 60 researchers at the Electro-technical Laboratory, Japan's national lab and its foremost electronics research organization, are at work trying to perfect applications for low-temperature superconductivity and to further develop the high-temperature materials.

One of its applications efforts involves using superconducting quantum interference devices (SQUIDs) to help detect heart and neurological abnormalities. In a laboratory, researchers test out a SQUID integrated onto an 8mm by 8mm silicon chip by testing it on subjects placed into a 6-feet by 6-feet square magnetically shielded vault which eliminates background "noise."

While this SQUID system isn't yet ready for commercial production, it is making progress. According to one American expert who examined it, "It makes the EKG look like a crude instrument."

Japanese researchers working on high-temperature materials also have a decided applications focus. Sharp is trying to use the high-temperature materials to develop galvano mag-

netic devices that detect slight changes in magnetic field.

If such devices can be made using high-temperature superconductors, their sensitivity could be increased several orders of magnitude over conventional devices, says Nobuo Hashizume, the deputy general manager of Sharp's central research laboratory. While conventional galvano magnetic devices are sensitive at 10^{-3} gauss, Sharp's high-temperature superconducting devices have already slightly beat that sensitivity. "The drawback is that we have to go to 77° Kelvin," which is the temperature of liquid nitrogen, to achieve superconductivity, says Hashizume.

To make it competitive, then, requires that it be significantly more sensitive than conventional devices, he says. "Our first goal is to increase

1,001 uses for superconductors

It's been said that superconductivity could have almost as much impact on mankind as electricity did a century earlier. Here is a sampling of potential electronics applications:

COMPONENTS

Analog/digital converter: The sampling rate of analog phenomena by a Josephson A/D converter is theoretically much faster than converters using conventional semiconductors, thereby markedly increasing the measurable frequency range.

Signal processors: Using high-temperature superconductors makes it possible to develop high-speed signal processors that operate at 50 times the sensitivity of conventional devices.

Optical switching devices: Potential applications range from fiber-optic communications systems to opto-electronic computers.

Sensors: A superconducting quantum interference device (SQUID) is the most sensitive detector of electromagnetic signals known. It comprises two Josephson junctions and can measure fields as small as one ten-billionth of the earth's magnetic field.

IC production: Synchrotron radiation is a million times more in-

tense than the light from photolithography and so can be used to fabricate microchips with hundreds of millions of bits of memory on a single chip. Conventional synchrotrons are 100-feet by 100-feet in size. Using low-temperature superconductors, the size has been reduced to 6-feet by 15-feet.

COMPUTERS AND PERIPHERALS

CPUs: Since superconducting devices do not generate heat, circuits could be packed closer, permitting smaller, faster computers. One use is in board-level interconnects; another is in Josephson junction devices with switching times 10 times faster than semiconductor switches.

Motors: For cooling fans, computer peripherals. When a magnet comes near a superconducting material, the superconductor repels it — a feature that could be used to spin electric motors with 50% lower current losses. Superconductor motors are about one-third the size of a conventional motor.

Bearings: For ultra-fast disk drives, high-speed cameras, gyroscopes. Because a superconductor bearing will repel a magnetic shaft surrounding it, there is virtually no friction between the parts, and the self-stabilizing bearing can achieve very high rotation rates.

COMMUNICATIONS

Millimeter waves: Josephson junctions made of superconducting thin films have successfully detected millimeter waves, which are difficult to detect using conventional semiconductors. The available spectrum for communications could be doubled with superconducting materials.

Antennas: An antenna made of high-temperature superconductors can be made 5% the size required for a conventional antenna. A superconductor version 2.6-inches long can replace the normal 52-inch long antenna used for commercial FM reception.

MILITARY

Power lasers: Magnetic energy stored in huge underground superconductor coils circulates indefinitely without loss of power and when needed, can be discharged rapidly. Military uses include power lasers and devices such as rail guns that fire high-speed projectiles at incoming missiles.

Shields and waveguides: By repelling-lines of magnetic flux and creating regions free of magnetic fields, superconducting shields could protect computer data.

Source: Superconductor Applications Association

sensitivity by three orders of magnitude, to 10^{-7} gauss." That will likely happen over the next three years or so, he projects.

In addition, Japan's aggressive advances in superconductivity smash the long-cherished United States view that the Japanese, for all their talents in implementation, cannot break new technology ground. According to William Attridge, a Tokyo-based United States marketing consultant to high-tech companies:

"Superconductivity is a test case in Japan's eyes of its newfound ability to innovate."

However, that ability is one that Japan values highly, and it's not all that difficult to imagine that the companies with the first superconductivity products will not be anxious to share their hard-earned secrets. Indeed, as the patents picture suggests, the Japanese are very hard at work seeking to ensure that they control as much of the proprietary technol-

ogy surrounding superconductivity as possible by filing for patents.

The key question surrounding superconductivity, then, is not if, but when. And right now, the tea leaves are pointing very strongly toward Japanese dominance of this new technology. □

David E. Gumpert is editor and publisher of The Cambridge Report on Superconductivity, an industry newsletter based in Cambridge, Mass.

Take the fast train to Miyazaki

First come the warnings: Your quartz watch will probably stop. If you have a camera with a motor, it will probably not work. VCRs and tape recorders will likely be rendered ineffective and recorded materials could be lost.

Then the briefing: Today's top speed will be 280 kilometers per hour, reached at 0.3 g acceleration (although the train has previously reached a top speed of 400 kilometers per hour).

And finally: Don't forget to fill out your questionnaire assessing how you feel about the vibration, noise and seat comfort level.

Then comes the ride for 20 visiting Americans on a 70-foot-long white and red magnetically levitated rail car that looks like a plane without wings and feels like a plane without the engine noise as it speeds down the seven-kilometer test track. Though the train weighs 17 tons, it floats 10 centimeters above magnets on the track bed, thanks to superconducting niobium coils wound around magnets on the train and cooled to nearly absolute zero by helium-filled tanks. On the back of each airplane-like seat is a three-inch-square Casio liquid-crystal color television display, in case you want to watch a live video of the ride.

There are no engineers on this train. Instead, three technicians are in a control room operating the com-

puter that turns the magnets on in sequence along the wedge-shaped "track" so as to accelerate and decelerate the train.

The mag-lev train is often cited as one of the more far-out applications of superconductivity, but in the Japanese resort town of Miyazaki, the mag-lev is here and now. Nearly 3,000 people have ridden the train since passenger cars were installed in early 1987. But only 30 of those people have been Americans.

The Japanese mag-lev has been under development since 1970 and,

so far, has cost the government about \$385 million. Since the passenger vehicle, known as the MLU002, began being tested last year, inquiries about constructing mag-levs have come in from such places as Las Vegas and Orlando, Fla., in the United States, Brazil, Australia and China, say officials.

But Japan isn't rushing off to another country to build a mag-lev, yet. "First it must be done in Japan and established as a good product," according to Hiroshi Takeda, deputy director of the Mag-Lev Development Division of the Japan Railway Technology Research Institute. Railway officials would like to see a 40km to 50km demonstration project between two Japanese cities to debug the train even further. He estimates the cost for such a project at about \$1 billion. But he notes that a similar project in the United States could cost less.

However, to get the next Japanese version up and running will probably take about three years. By that time, Japan will be ready to tackle foreign markets. At the same time, Takeda is impressed with the potential American market — such corridors as New York to Washington, D.C. and Orlando to Miami. But what really makes his eyes light up is a country closer to home. "Just think of China..." according to Takeda, as his voice trails off. □



Gandhi: Foreign investment in India is not an "open door"

India's Prime Minister Rajiv Gandhi reaffirms his commitment to high-tech deals with the West. One catch: Business will be done only on India's terms

BY BRUCE C.P. RAYNER

In the four years that Rajiv Gandhi has served as Prime Minister of India, liberalization of the country's electronics industry has accelerated. It is no coincidence. Gandhi—who assumed India's leadership after the assassination of his mother, former Prime Minister Indira Gandhi, in 1984—is a strong proponent of technological change. He constantly challenges both government and business to work toward a more efficient industry.

But while Gandhi is committed to a technological revolution, some critics claim the momentum is slowing. Still, Gandhi is adamant that the policy of liberalization started in the early 1980s will continue. In this, the conclusion of a two-part series, ELECTRONIC BUSINESS scrutinizes Gandhi's policies toward foreign businesses and examines India's telecommunications and computer markets.

During an interview with ELECTRONIC BUSINESS, the Cambridge University-educated Gandhi reaffirmed his commitment to past policies. When asked whether his country would continue to allow greater freedom for both foreign and domestic electronics companies in India, Gandhi's response was an adamant "absolutely."

Software, Gandhi says, is perhaps the most important area for growing investment by foreign firms. Since the government came out in late 1986 with a revised software policy, more emphasis is being given to the software industry's potential to attract foreign investment and generate exports.

The new policy is beginning to bear fruit. Last year, Microsoft Corp. inked a deal with an Indian software house to sell its packages in India, and this month Ashton-Tate is re-

portedly following suit. As for exports, India expects to ship \$250 million worth of software this fiscal year ending in March, according to the Department of Electronics. Some of that much-needed foreign exchange is expected to come from a deal struck between the Commonwealth of Massachusetts and the Indian government for software exports from Pune, India to the U.S. market via Boston.

On opposite sides

Such relationships are a new phenomenon and look to be the wave of the future. But it was not so long ago that India and the United States were on opposite sides of the ideological fence. In fact, India is still angry with the United States for funneling arms through Pakistan to the rebels in Afghanistan. And the United States is not too keen on Gandhi's

close ties with the Soviet Union. But business is business and Gandhi wants to insure India's technological growth will be tied to the West.

To this end, India's leader made two visits to the U.S. during Ronald Reagan's presidency that helped to thaw relations between the two countries. On both visits, closer business cooperation, particularly in the electronics industry, was discussed with concrete results. Indeed, in 1985 the two leaders signed a memorandum of understanding which was a step toward easing restrictions on the transfer of U.S. high technology.

India desperately needs access to more technology if it expects to transform itself into a world class player. Gandhi accepts that this technological transformation "is not an event, it is a process." Last April, he acknowledged, "A successful transformation requires change across the board." That includes changes in government policies, changes in industrial and management tactics and changes in labor attitudes. "We must not be afraid of looking for new solutions to emerging problems," he added.

Supercomputer tiff

A case in point is the 1987 sale of a Cray Research Inc. XMP-14 supercomputer to India. After much political haggling—the United States feared the supercomputer would be used to develop nuclear weapons, although India promised it was for weather forecasting—the machine was reportedly shipped late last year.

While India looks to the West for its technological development, there is a caveat limiting the amount of foreign control that Gandhi will allow. He is serious about India's self determination and insists Western companies will not be permitted to bully their Indian partners. India's

A quick guide to India

	Fiscal year ending March 31.	
	1987	1988
GNP (constant \$ billions)	\$141.9	\$144.9
Per capita GNP (constant \$)	\$184	\$184
Population (millions)	770.0	785.4
Labor force (millions)	303.2	311.1
Balance of payments (\$ millions)	\$73.0	-\$366.0
Balance of trade (\$ billions)	-\$6.52	-\$6.42

Sources: GOI Central Statistical Organization, Reserve Bank of India, GOI Economic Survey, World Bank and U.S. Department of Commerce

foreign investment policy is not an "open door policy," he asserted.

"We permit foreign investment on our terms, in a wide range of sectors within certain percentages of foreign equity," Gandhi said. Those percentages of ownership are, for the most part, fixed at 40%. But while India will reexamine its centrally planned economy, there will always be room within that framework for foreign investment, he adds.

Gandhi told **ELECTRONIC BUSINESS** that one of the advantages that foreign companies can gain from working in India is the increased access it gives them to third-party countries. "We have certain expertise at working in difficult climatic conditions," he says, "for example, in rural telecommunications." Such expertise coupled with Western high tech can be a winning combination for sales to Africa, Asia and the Middle East, Gandhi asserts. Indeed, India's close economic ties with the Soviet Union and the Eastern Bloc countries can provide additional trade advantages for U.S. firms.

Whether Gandhi will be around to guide the country through its electronics transformation is up for debate. Some political analysts speculate that the election, slated for the end of 1989, could be a close race. The opposition parties are forming a coalition that, if it holds, might be strong enough to oust him from office.

Corruption charges within the ruling Congress party are rife and have even reached the inner circle of the Prime Minister's office. Critics also say that the country's civil unrest is taking up too much of Gandhi's time, preventing him from playing a stronger role in molding the country's technological future.

But like the rest of the world, Indians vote with their pocketbooks. And



Prime Minister of India Rajiv Gandhi is serious about India's self determination and insists Western companies will not be permitted to bully their Indian partners

pocketbooks are now bulging. A fruitful monsoon season last year helped produce a bumper crop which will boost GNP growth back onto a 4% to 5% range, well above the lackluster 1.9% figure of 1987. What is more, inflation is falling, stock prices are up and business confidence is high, which could prompt Gandhi to call for an early election.

Furthermore, Gandhi's popularity has been waxing after Indian paratroopers squelched the attempted coup in the Maldives last November. Such a show of strength is good for

a bit of political mileage, given the backdrop of strife that Gandhi is having with the Sikhs and the Sri Lankans. To add to his good fortune, the opposition is having its share of internal problems.

In fact, many pundits say Gandhi would be foolish not to call for an early election. By most accounts, it could take place as early as this March. If that is the case and Gandhi gets reelected for another five-year stint as Prime Minister, the country's electronics revolution should continue intact. □

Crackle, crackle . . . It's India on the line

India is planning to spend nearly \$37 billion on telecom gear by the year 2000. The Japanese are eager. Where are the U.S. suppliers?

BY BRUCE C.P. RAYNER

Making a telephone call in India is often an exercise in futility. The connections are bad; the traffic is high; and the equipment is outdated. And that's on a good day. For most of the 800 million Indians, mere access to a telephone is out of the question. There are only about 4 million telephones in the entire country — and just 40,000 of those are public.

But all this is about to change. India's Department of Telecommunications (DOT), the central telecommunications authority, is planning to double the number of subscriber lines from about 4.0 million now to 9.5 million by 1995. It then wants to double that again to 20 million by the turn of the century.

Obviously, a lot of money will be spent. Ball-park estimates of around

\$37 billion to be spent over the next 11 years are being bandied about by the Indian government. The U.S. Department of Commerce estimates that \$8 billion is earmarked for direct imports. U.S. companies, however, are hardly ecstatic. For various reasons, many U.S. suppliers have taken a somewhat lackadaisical attitude toward India. But other competitors, most notably the Japanese, have already begun to gear up for what could become one of the most lucrative markets for telecommunications equipment in the world.

Of the total \$37 billion figure slated for telecommunications investment, \$3 billion is earmarked for fiscal 1989, ending March of next year. Roughly \$10 billion will be doled out from 1990 to 1995 and the remainder

between 1996 and 2000, government sources say. Of the total investment, the government will only ante up about half. The rest will come from private investors, both foreign and domestic.

High on India's must-have import list are transmission and test equipment, traffic generators, pay phones and a host of business and office telecommunications equipment. India is also hungry for fiber-optic technology and components so it can get its domestic producers up to speed. The long-term strategy is to install a digital fiber-optics-based system.

For foreign telecommunications firms with little or no history in India, the best point of entry is in the business market: facsimile machines, modems and local area networks are all areas targeted for growth. It's no wonder, given the shortage of such equipment in India. There are currently only about 500 fax machines there, according to one government source.

Now is the time to act, assert market gurus, before import opportunities quickly dry up as more Indian companies start producing these types of equipment. Because of the government's favoritism toward domestic companies, foreign firms could soon run into high import duties and, perhaps, out-and-out bans, fear pessimists. One alternative is to set up a joint venture with an Indian company and begin local manufacturing.

For United States suppliers hoping to get a piece of the action, a good starting point for gathering information is the United States Department of Commerce, which led a telecommunications mission to India last year. In addition, another option is the country's major engineering trade show, scheduled for next month in New Delhi, which offers a forum to



Krishna Tannu, regional vice president of newly formed AT&T India Ltd: "India is one of the major growth opportunities in developing nations"

India's ambitious telecommunications plans

	1988	1990	1995	2000
Local telephone connections (millions)	3.2	4.5	9.5	20.0
Telex connections (thousands)	30	55	100	200
Villages having public telephones or exchanges (thousands)	32	43	100	600
Voice/data connections for business/industry (thousands)	few	10	100	800
Capital investment needed (\$ billions)	\$3.62	\$7.05	\$17.11	\$36.58

Figures are on an installed basis.
Conversion rate: 14.9 rupees = \$1

Source: Department of Telecommunications, Government of India

explore telecommunications and electronics business opportunities there.

Fiercely independent

In typical Indian fashion, the country is pursuing a fiercely independent telecommunications strategy. India is unique, insists Sam Pitroda, Advisor to the Prime Minister for Technology Missions. Consequently, Pitroda contends that the country has unique demands for a national telecommunications system that differs markedly from those in the West. Pitroda is a key player in shaping India's telecommunications policy. However, he strongly advocates an indigenously developed and built telecommunications system that limits imports to subsystems and components as needed.

Pitroda's vision is being implemented. A program is underway to put telephones in India's 600,000 or so villages, a daunting task as only about 35,000 villages are currently serviced.

For the job, the Center for the Development of Telematics (C-DOT), a government agency, designed a rural automatic exchange (RAX) to survive with minimal maintenance in India's harsh climate. Even though the project is domestic, a lot of the components are coming from overseas, says Sunil Abrol, C-DOT's registrar. So far, 25 RAXs have been installed and the DOT plans to have

a total of 400 installed by the end of 1989, says Abrol. In the last four years, C-DOT also designed two other exchanges: a PBX system that has so far been installed in 300 offices and a main exchange that is up and running in New Delhi and Bangalore.

All three of these domestically developed exchanges are manufactured by both private and public companies in India. Other government-sponsored projects include digital multiplex equipment, digital micro-

For most of the 800 million Indians, mere access to a telephone is out of the question

wave systems and satellite communications equipment, all of which utilize domestically produced parts.

This indigenization kick is a radical departure from the past. Over the last 40 years, when all the big switching and transmission contracts were being tendered, the companies that got the business were all European. Many of the contracts were tied to economic aid packages. France's Alcatel got a number of big switching contracts and companies like L.M. Ericsson, N.V. Philips and Siemens

AG scooped up the rest. American companies simply missed the boat.

But with this new opportunity to participate in the market, many American companies have no intention of being left out again — especially not AT&T. "Just because we were late for lunch, doesn't mean we will be late for dinner too," states Krishna Tanuku, regional vice president of newly formed AT&T India Ltd.

Tanuku heads a liaison office in New Delhi which was set up to explore India's telecommunications needs. "India is one of the major growth opportunities in developing nations," he says. As examples of possible opportunities for AT&T, Tanuku points to possible collaborations with C-DOT as well as technology transfers to Indian companies in areas like fiber optics. Besides telecommunications, opportunities exist in Unix and other business computer applications, he adds.

Not everyone shares AT&T's optimism. Rockwell International Corp.'s communication systems division, headquartered in Irvine, Calif., also has a New Delhi liaison office which is keeping its eye out for business opportunities. But Gilbert Amelio, the division's president, says that new business is very slow in coming.

"Everything is highly politicized," Amelio complains, referring to the tight reins the DOT keeps on growth and limits to foreign ownership. While he claims to be interested in setting up a joint venture in India — possibly with C-DOT — the Rockwell executive insists the 40% foreign ownership cap is a serious concern. At this point, India is simply not a priority, he adds.

With that kind of attitude, Rockwell might miss out on India's telecommunications boom as history threatens to repeat itself. But this time, instead of the Europeans, the new challengers will be coming from Asia. Japan has been making a strong showing in India over the last few years and looks to be intensifying its efforts. Companies like Fujitsu Ltd., Furukawa Electric Company Ltd., Oki Electric Industry Company Ltd. and Tamura all already have lucrative technology transfers and joint ventures in India. So, unless the U.S. begins to act now, it could find itself dialing the wrong number as the year 2000 approaches. □

Foreign firms chip away at the U.S. defense arsenal

The military electronics marketplace is no longer as American as apple pie. Foreigners are making inroads. Here come the Japanese

BY BRUCE C.P. RAYNER

The Department of Defense (DOD) is growing nervous about the increasing foreign content in its \$300 billion a year defense arsenal. While the percentage of prime contracts awarded to foreigners has remained relatively constant over the past few years, there are indications that the foreign content of electronic components in subcontracts — for which there are no official figures — is on the rise.

Foreign vendors — through their U.S. subsidiaries — are also becoming more active in the U.S. military electronics marketplace. Some are teaming up with U.S. defense manufacturers to bid on Pentagon contracts. Others are going directly after U.S. contracts.

To many on Capitol Hill, the increasing globalization of the military

electronics market is a disturbing trend. In fact, in a recent study by the General Accounting Office conducted for Sen. John Heinz (R-Pa.), the GAO concluded that "in a national emergency, the consequences of extensive dependence on foreign sources could be extreme."

Says a spokesperson for Heinz: "It makes you nervous that we are in fact not procuring from the domestic base to a greater extent." One of the primary jobs for Robert McCormack, the newly appointed Deputy Undersecretary of Defense for Industrial and International Programs, is to analyze the extent of this foreign dependence.

The industry segment which has been singled out for the most attention is, of course, semiconductors,

the 13th most critical industry for national security, according to the Logistics Management Institute (LMI), a government research center. In total, the DOD buys 27.6% of America's total consumption of chips. Of that total, about 30% is sourced offshore, the LMI estimates.

To some extent, the U.S. government's \$100 million a year stake in Sematech, the Texas-based semiconductor consortium, is a direct result of the DOD's concern with foreign dominance in semiconductors. [See ELECTRONIC BUSINESS cover story, May 1, 1988.] But what may be even more disturbing than the rise of the Asian semiconductor industry, defense analysts say, is the direct investment in the U.S. industrial base by foreign firms.

Foreign direct investment rose from \$83 billion in 1980 to \$209 billion by 1986, reports the Bureau of Economic Analysis. In 1986, 32.5% of that was in manufacturing. At the same time, U.S. direct investment abroad has grown more slowly, from \$215 billion in 1980 to \$260 billion in 1986.

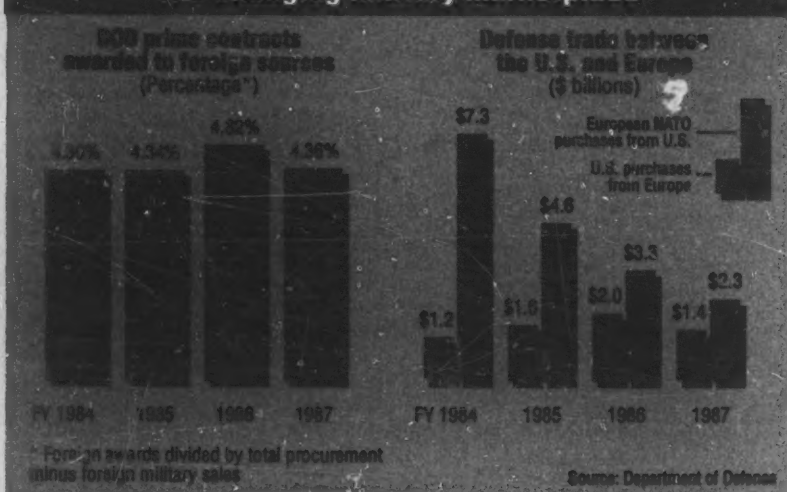
The Defense Department publicly insists that it is not concerned with the trend, as long as it can insure the integrity of national security. However, privately, many defense and government officials are worried, say European defense executives.

European competition

"Right now there is a wave of protectionism that is running quite high, based on the amount of foreign investment, primarily in the political arena," comments James Bell, president of Thomson-CSF Inc., a U.S. defense subsidiary of Thomson-CSF, the largest defense electronics manufacturer in France.

European military contractors say their American counterparts are wor-

The changing military marketplace



While the percentage of U.S. prime contracts awarded to foreigners remains relatively constant, the defense trade with Europe is becoming more balanced



ried because while foreign prime contracts account for about \$4 billion of the DOD's annual budget, the amount of contracts going to foreign-owned U.S. subsidiaries is rising.

Meanwhile, European defense firms are aggressively pursuing U.S. expansion. The dollar's fall over the past few years has meant lucrative U.S. investments, while shrinking European defense budgets have forced many companies to look elsewhere for business.

But strategies differ among European military contractors with offices here. As a rule, the British are the most aggressive, partly because of the close government-to-government ties between Britain and the United States. Britain's Plessey Company Plc, for example, is busy buying up U.S. and Canadian defense companies, while British Aerospace (BAe) boasts a total of 23 collaborative ventures with U.S. firms. BAe recently bought Reflectone Inc., a Tampa, Florida-based simulator company, to add to its war chest.

Germany's Siemens AG — which recently joined General Electric Co.

(GEC) of Britain (no relation to the U.S. General Electric Co.) in a \$3.12 billion bid to take over Plessey — is actively teaming up on a variety of defense contracts with the likes of Boeing Co., Litton Industries Inc. and Texas Instruments Inc. Aside from the bid for Plessey, acquisitions of military vendors in the United States are not in the cards, according

About 30% of the DOD's chips are sourced offshore

to one Siemens spokesperson.

Thomson-CSF is also fighting for its share of the U.S. military electronics market. "To maintain and increase your market share, you have to look at ways to get into bigger and more complex activities," comments Thomson's Bell. The company's big success in the United States is its 1985 team-up effort with GTE's Government Systems Corp. to adapt

its RITA battlefield communications system for the U.S. Army's Mobile Subscriber Equipment program.

Thomson's goal is to double its \$340 million sales in the U.S. defense market within the next five years, says Bell. It is doing that through an "aggressive marketing drive" that includes acquisitions — it purchased Wilcox Electric Co. in early 1988 — as well as marketing efforts on behalf of the RITA system to the U.S. Marines and the U.S. Air Force.

The wild card

While the Europeans are pounding away on the U.S. market, the real wild card in the 1990s is going to be Japan, analysts claim. While some say the constitutional ban on defense exports is strong enough to prevent Japan from selling internationally, others believe politicians will be able to sidestep the limitations.

It is only a matter of time, these analysts say — maybe five to 10 years — before the country enters the international defense marketplace. The cracks in its resolve are already showing. For starters, Japan is par-

ticipating in the Western Pacific Strategic Defense Initiative umbrella with the U.S. Department of Defense.

"The U.S. has an interest in a number of technology areas in Japan, and I think, over time, there will be more activity in this regard," says Robert Martin, director of Asian and Latin American operations at the System Planning Corp., a defense consulting and contracting firm in Arlington, Va. Particular areas of interest to the United States are laser technology, demagnetizing technology for ships, fiber optics, avionics guidance systems and manufacturing process technology, sources say.

However, Martin believes the Japanese are in no rush to jump into the international marketplace. This is partly because of their constitutional constraints and partly because "they don't want to give away their technology to the Yanks," he says.

The real test of Japan's international intentions will be the FSX, says Robert Fraser, senior defense analyst at Arthur D. Little Inc. Even though it is built around the F-16 shell, Fraser believes the FSX will bear little resemblance to the F-16 when it rolls off the production line in the mid-1990s. In fact, most of the high-tech avionics will be stamped "Made in Japan." By that time, many believe, Japan's Ministry of International Trade and Industry (MITI) will have effectively dismantled the Japanese government's constraints on exporting defense goods.

But even if Fraser is wrong, the Japanese will continue to penetrate the U.S. defense market via the commercial channel. A case in point is a small Southern California company (whose president requested anonymity) that is manufacturing rate sensor packages — gyroscopes, excellerometers and electronics packages — for the Air Force. It is using technology instead of components supplied by Japan Aviation Electronics, Mitsubishi Heavy Industries and Mitsubishi Electric Corp. in one \$380,460 contract.

The president of the contracting firm admits that he intends to develop closer ties with Japanese companies in hopes of taking advantage of technology transfers in the future. This is one forward looking U.S. company that is betting on the Japanese taking the FSX global. □

What lies ahead — A view from the top

Deputy Undersecretary of Defense McCormack discusses the implications of globalization on the U.S. defense industry

Robert McCormack, the Deputy Undersecretary of Defense for Industrial and International Programs, as of October 1, 1988, has the thankless — and according to some critics, impossible — task of bringing these two seemingly conflicting programs into harmony. If he can hold onto the job in the new Bush administration, McCormack will be the man to watch as the DOD shapes policy for the "globalization" years of the 1990s.

The newly created position traces its origin to a July 1988 report by Robert Costello, Undersecretary of Defense for Acquisition, which recommends ways to bolster the defense industrial base. Among other things, Costello charges McCormack with improving manufacturing programs, providing visibility into foreign military dependency and increasing activity in the Pacific Rim. A tall order, to say the least.

McCormack recently spoke with ELECTRONIC BUSINESS on what lies

ahead for the U.S. defense industry. Following are some of his comments.

EB: How will your office begin to try to minimize foreign dependence on foreign electronic components?

McCormack: The issue is not minimizing foreign dependency as the first order of business. The issue is to determine where that type of dependency exists. So the first question is to identify whether there could be a problem of sourcing something in the event of an emergency. The way that is going to be implemented is that the services themselves — as they are looking at their procurement of weapons systems — are going to take a look at that.

In other words, if they are assuming they are going to be able to buy 50% more of X [a weapons system] over some period of time, the question is: can you indeed do that, and can you determine what the vulnera-



What it takes to get through a DOD audit

Surviving an audit can make the difference between winning and losing a defense contract. It can also make the difference between going to jail and staying in business

When the Defense Contract Audit Agency comes knocking on the doors of defense electronics firms, executives had better be prepared. Recently, however, many defense contractors have not been prepared. The number of fraud cases and suspensions is climbing and the value of contractor overcharges is rising. Is the DCAA cracking down or are contractors slacking off?

The answer is: both.

The simple fact is that employee ignorance is at the heart of many cases of overcharging, according to Phillip Rogers, executive officer at the DCAA, the government's defense auditor. "A lot of the time company employees just don't know what their responsibilities are," according to what Rogers says. That is serious: not reporting updated material costs or not keeping accurate track of hours worked is tantamount to criminal negligence.

A Pentagon source estimates that the DCAA uncovered overcharging on nearly 50% of all contracts re-

BY BRUCE C. P. HAYNER

viewed over the past two years. How much resulted from criminal wrongdoing as opposed to sheer ignorance, however, is unclear. Still, the discrepancies translate into big bucks. In fiscal year 1988, the DCAA says it saved taxpayers \$9.5 billion on over-inflated defense contracts.

The bottom line

The bottom line for defense contractors is that the DCAA is finding more to complain about. And, because of the DCAA's power over contractors, there is little love lost between the two. Many contractors complain that the DCAA taxes their already overtaxed financial departments and some accuse the auditors of overkill and nitpicking. They argue that auditors waste both time and money in their endless paper chase. One contractor estimates the annual cost of audits at between 2% and 3% of total sales.

The DCAA conducts a variety of audits. Most common are the proposal audit and the incurred cost

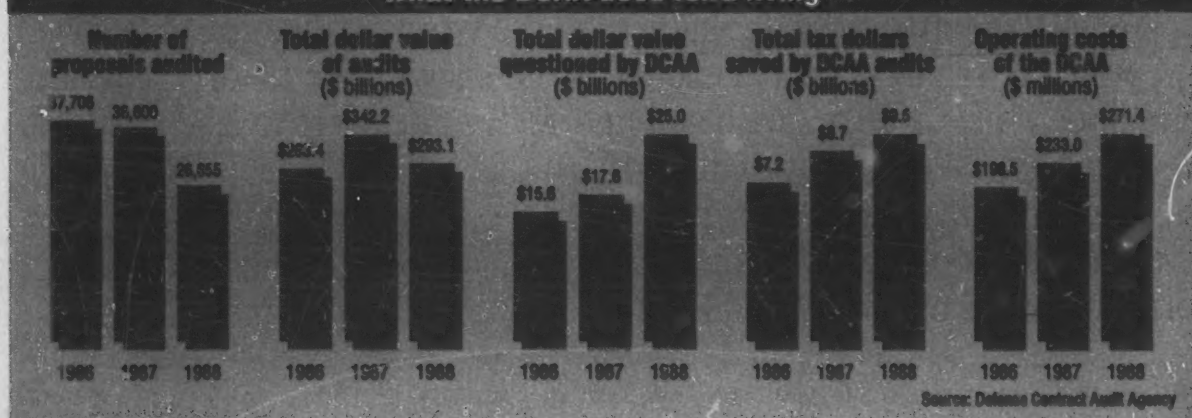
audit. The first evaluates a contractor's proposal and looks at the cost breakdown. The second looks at the costs of an already awarded contract to see if the incurred costs match the projected cost.

In light of recent defense scandals, the DCAA is recommending tighter regulations. The agency has suggested stricter guidelines for hiring consultants. And a few years ago, it began streamlining its fraud referral procedure. In fiscal 1987, 287 referrals were made — an 86% increase over the year before — according to congressional testimony by Fred Newton, deputy DCAA director.

In fiscal 1988, however, that figure dropped to 191. The 33% decline is attributed to an increase in voluntary disclosures and an increase — to over 1,000 — in the number of contractors debarred or suspended from bidding on defense contracts, says the DCAA's Rogers.

The crackdown ironically comes at a time when the DCAA says it is sorely understaffed. The Defense Department requested an additional 1,025 auditors. But until they materi-

What the DCAA does for a living



MARKET PERSPECTIVES

MILITARY ELECTRONICS

alize, the agency relies on "risk assessment" in determining who gets audited and to what extent.

Prime targets include big contractors and subcontractors with over \$10 million in auditable contracts; any contractor with a problem track record; and any new players to the game. The DCAA auditors pay particular attention to contractors that are simultaneously working on both cost-plus and fixed-price contracts in house.

Corporate education

For the concerned contractor, the answer to surviving a DCAA audit is corporate education. That doesn't just mean educating the executives, but *all* the employees who play a part in the contract process. Rogers recommends participation in the Federal Acquisition Regulation (FAR) self-governance program as a way to prove to the DCAA that the company is serious about internal education.

Rogers suggests that companies conduct employee training programs explaining the importance of such issues as The Truth in Negotiation Act, a law requiring defense contractors to supply current cost and pricing data on noncompetitive contracts up to the time the contract is awarded.

The DCAA insists that most contractors maintain comprehensive financial and cost accounting systems in keeping with Congress' Cost Accounting Standards (CAS), as well as the standards of the American Institute of Certified Public Accountants. These are necessary for accurately capturing costs and estimating rates, says Rogers. Small businesses generally aren't required to comply with CAS, though many do simply because it makes good business sense.

As an added safeguard, Rogers suggests contractors employ an outside auditor, preferably a Big Eight accounting firm, to check the books even if the company is privately held. The more closely held the company and the more heavily guarded the books, the more the DCAA will want to dig, he says.

For newcomers to the defense game, the DCAA offers a pamphlet called "Guidance for New Contractors," a good starting point for information gathering. Contractors also recommend membership in the National Contract Management Association, based in Virginia.

Contractors, however, aren't wildly enthusiastic about DCAA auditors. They "should use some common sense in what they really have to audit," says William Tannaz, director of contracts at MagneTek ALS, maker of the power supply for the U.S. Navy's AEGIS CG-47-class guided-missile cruiser. For example, in 1988, the DCAA was requested to audit the company's old insurance policy from when it was a small business, even though ALS had already been acquired by MagneTek Inc., a large comp. (Whenever a small company becomes a large company, the reporting requirements change.)

Another criticism is that for in-house DCAA auditors, the company winds up training new auditors. Richard Foster, president of Interstate Electronics Corp., a Figgie International Inc. company, claims that

of the eight auditors that Interstate houses, only three have more than one year of experience. "There are tremendous inefficiencies in the process," Foster says.

The audits can be expensive in more ways than one. Last October, Sundstrand Corp. paid \$127 million in fines, damages and penalties for mischarging on government contracts. In August, TRW Inc. was hit with a \$6 million bill after pleading guilty to overcharging.

But while contractors complain about the time and effort it takes to satisfy the DCAA, they all grudgingly agree the audits are necessary. To make the process easier, what is needed is a closer, more cooperative, relationship between the contractor and auditor, they say. Translation: the contractor must always be ready to open the books on demand. □

Blow by blow: One real life audit drama

Interstate Electronics submits an \$8.4 million bid to the Air Force and opens its doors to government auditors

The best way to provide insight into the audit process is to spell it out, step by step. What follows is a case study of a proposal audit by the Defense Contract Audit Agency (DCAA) of a fairly typical defense electronics firm.

On May 11, 1987, Interstate Electronics Corp. of Anaheim, Calif., submitted a "best and final" \$8.4 million bid to the Air Force for a range application translator for a global positioning system (GPS), which provides positioning data for tracking satellites and missiles. Interstate, a subsidiary of Figgie International Inc., is a leading maker of test instrumentation for weapons systems, intelligence and electronic warfare systems, as well as flat-panel display technology.

By the end of May, the Air Force's procurement contracting officer (PCO) had made a request for a proposal audit of Interstate through the Defense Contract Administration

Service (DCAS). The DCAS is the contract management arm of the Defense Logistics Agency and oversees the majority of Defense contracts. In most audits, the PCO contacts the administrative contract officer (ACO) at the local DCAS office, and the ACO, in turn, contacts the local in-house DCAA auditors at Interstate's Anaheim facility.

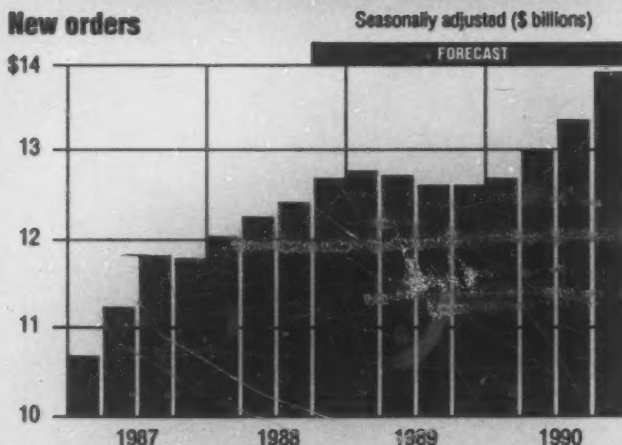
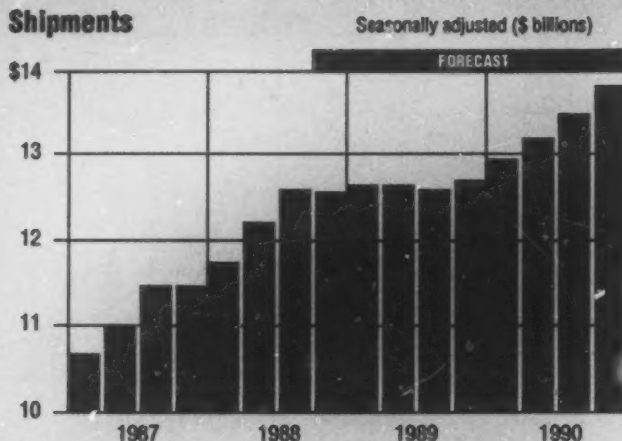
While the DCAA was doing its cost audit, the DCAS conducted a technical review of the GPS translator. The DCAS auditors evaluated engineering plans and determined whether or not the materials and labor that the company said it needed to build the translator were legitimate. The DCAA auditors, on the other hand, looked into the cost reporting and rate estimates that the company submitted in its bid to the PCO. In total, these two "physical" audits lasted about 30 days. The entire audit process, including report writing, took 45 days.

Both Interstate's pricing depart-

BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

Scientific & engineering instruments



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Instruments posted a 10% sales gain in 1988

In the first 10 months of 1988, shipments of scientific and engineering instruments climbed to \$40.66 billion, a gain of almost 10% from the level in the January through October period of 1987. It looks like once all the data is tabulated for 1988, the annual increase will end up being about this same amount. This rise will be on top of the 9.5% hike in shipments the industry reaped back in 1987.

While 1988 will go down on the books as a good year for sales gains, it also marks the end of the expansionary phase of the current business cycle and a turn into a period of slower growth. In particular, increases in new orders for scientific and engineering instruments started trailing off last year. In the first quarter, new orders surged 12% from the same period in 1987, while in the second quarter, growth was about 9%. However, by the third quarter, the hike to the comparable three months in 1987 dropped to 5%.

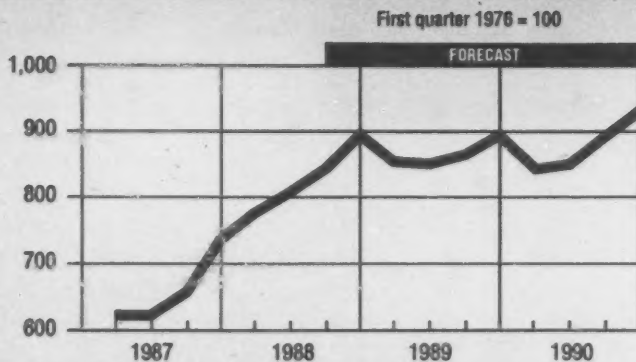
But, the scientific and engineering instruments industry is expected to weather the business contraction without getting totally squeezed off. U.S. factory shipments of these instruments is still forecast to crawl up another 3% in 1989, bringing the annual figure to \$50.6 billion. One factor helping this industry is its level of backlog. For the month-end of October 1988, unfilled orders were valued at \$12.96 billion, about 5% ahead of the previous year.

According to the ELECTRONIC BUSINESS ATE Sales Index, the automatic test equipment sector was a star player in the overall industry's performance. In the third quarter of 1988, the ATE Sales Index swelled 28% from the same quarter a year earlier. For all of last year, worldwide sales are expected to total \$2.26 billion.

Because the ATE market is so strongly affected by the volatility in the semiconductor industry, its business cycle swings tend to be more pronounced, too. But, better inventory management and export opportunities are expected to translate into more stable growth for ATE this year. The ATE Sales Index is expected to jump about 4% in 1989. In general, the need for increased efficiency and quality to remain competitive and boost market share will continue to spur sales of test, measurement and inspection equipment this year.

MADLINE FRANCHI

ELECTRONIC BUSINESS ATE sales index



Historical data: ELECTRONIC BUSINESS; Forecast: Cahners Economics

BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

Computer output still heading up

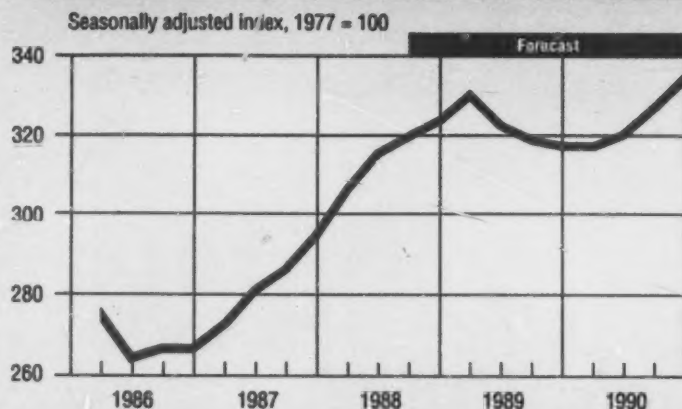
Average industrial production of computers and office machinery in the third quarter swelled 12% from the same period in 1987. Average quarterly output has been on an uninterrupted rise since the first quarter of 1987 as businesses ordered more information-processing equipment. In the July through September period, private purchases of computer and office equipment reached an annualized \$41.8 billion, a gain of 12% over last year's third quarter.

A portion of production has gone to restocking of inventory and meeting foreign demand. At the end of September, inventory valued \$11.8 billion, or 15% above the \$10.3 billion estimated in September 1987. Third quarter exports expanded 21% from third quarter 1987 to total almost \$5.6 billion.

Output levels will keep rising through part of 1989, but the rate of growth will start to ease soon. Evidence is filtering in that the expected slowdown in the industry has started. Although new orders and shipments in the waning months of 1988 were still above their respective 1987 levels, the rate of that growth was getting smaller than earlier in the year. October shipments confirmed this trend. From September to October, shipments fell by 1.4% to \$5.69 billion. This left the monthly book-to-bill ratio at 0.96, which was the second month the ratio was below 1.0.

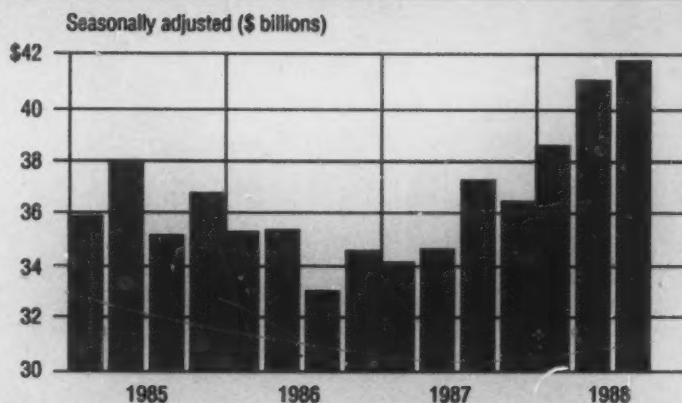
MADLINE FRANCHI

Computers and office machinery — Industrial production



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Computers and office machinery — Purchases



Source: U.S. Commerce Department

Computer market database

Latest quarter: 3rd quarter 1988							
	Latest quarter	Previous quarter	Change	Year ago	Change	Next year	Change
Industrial production (SA, 1977=100, qtr. average)	319.5	315.0	+1.43%	285.0	+12.11%	318.3	-0.38%
Shipments (SA, \$ millions, qtr. total)	\$17,406	\$17,290	+0.67%	\$15,661	+11.14%	\$17,183	-1.28%
New orders (SA, \$ millions, qtr. total)	\$17,306	\$17,381	-0.43%	\$15,639	+10.66%	\$16,515	-4.57%
Unfilled orders (SA, \$ millions, qtr. total)	\$13,720	\$13,820	-0.72%	\$14,114	-2.79%	\$13,385	-2.44%
Inventory-to-shipment ratio (SA, end of qtr.)	2.03	1.91	—	19.92	—	2.05	—
All employees (thousands, end of qtr.)	518.0	513.9	+0.80%	486.2	+6.54%	515.7	-0.36%
Production workers (thousands, end of quarter)	167.3	168.3	-0.59%	164.6	+1.64%	165.0	-1.46%
Exports (\$ millions, qtr. total)	\$5,596	\$5,638	-0.75%	\$4,635	+20.74%	\$5,994	+7.12%
Imports (\$ millions, qtr. total)	\$5,759	\$5,558	+3.62%	\$4,897	+17.61%	\$6,213	+7.89%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

NOTE

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

JANUARY 23, 1989

1989

ANNUAL

**Financial facts and
figures on the
electronics industry**

A supplement to Electronic Business

1989

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Financial facts and
figures on the
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A supplement to *Electronic Business*

All the world loves a winner, and never more so than when the interested party shows up at the top of the league. The next best thing is gauging your company's financial performance against that of your competitors — and finding that you're ahead.

But the comparisons go nowhere without hard data from authoritative sources. The editors of *ELECTRONIC BUSINESS* are proud to bring you that information in this special supplement, a compendium that will prove a valuable reference tool in the years to come.

The supplement pools eleven of the best rankings published in the 1988 issues of *ELECTRONIC BUSINESS*, from the widely quoted *ELECTRONIC BUSINESS* 200 to a rating of the 100 electronics companies that produced the highest return on investment. Each is the product of painstaking, original research by our staff editors; collectively, they support our stance that electronics is a truly global industry.

Kicking off the supplement is the *ELECTRONIC BUSINESS*

200, a listing by revenue of the top 200 publicly held U.S. electronics companies that is as important to senior electronics executives as the *Fortune* 500 is to the broader business world. The "200" spins off plenty of value for our readers: the ranking of the fastest-growing firms, and the list of top ROI performers, for example, owe their origins to the Sisyphean number-crunching that goes to make up the top 200.

But the electronics industry does not start in Silicon Valley and end inside Boston's Route 128 beltway. Japan needs an introduction as the other industrial giant, and Europe is re-emerging as the vital "third force"

— hence our rankings of the top electronics players in those sectors of the globe.

For those with a corporate passion for beating the IRS, there's invaluable detail on which companies paid what taxes. And if you like keeping track of how much the top brass really make, then the dollar figures on the top 100 highest-paid executives will give you plenty to go on. Enjoy.

JOHN KERR, editor

TOP PERFORMERS IN ELECTRONICS, COMPUTERS AND SYSTEMS — WORLDWIDE

6 *ELECTRONIC BUSINESS* 200

Sky-high and heading higher. Total net income for the top 200 largest U.S.-based computer and electronics makers rose more than 50% to \$41 billion after two years of declining growth.

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After two hard years, Japan's major electronics producers are starting to see results from their efforts to cope with the high-valued yen.

60 Top European companies

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70 Fastest growing companies

It was the year of the workstation, with Sun Microsystems topping the list of fastest growing electronics and computer companies in the U.S. with a remarkable five-year compounded annual growth rate of 474%.

80 Top R&D spenders

Led by software, capital equipment and minicomputer sectors, R&D spending by U.S. electronics and computer companies was up 21.5%.

100 Top paid executives

Big increases in profitability of U.S. electronics and computer companies translated into an average 23.5% increase in salary for top-paid electronics executives.

108 Top capital spenders

Capital equipment spending at electronics and computer companies in the U.S. was up 3.9% to \$14.3 billion.

116 The best in electronics

Our annual poll of the most admired companies and executives in the U.S. electronics industry.

129 Top distributors

Paced by increasing semiconductor demand, most electronics distributors posted double digit increases in revenue.

136 Top ROI performers

U.S. electronics and computer companies are beginning to focus on their return on investment and return on equity.

146 Top taxpayers

For the 130 companies on this year's list, the average effective tax rate dropped to 39.4%. Over 60% of taxes went to foreign governments.

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The 200 Sky-high and heading higher

The signs are positive. Total net income for the 200 leaders rose more than 50% to \$41 billion after two years of declining growth

After the exuberant highs of the early days and then the shocking reversal in 1985, the electronics industry is finally settling down. No longer driven by uncontrolled growth, the new, mature industry is more interested in expanding profits than revenue. Today's cautious managers now see that the wild growth that turned so many start-ups into market leaders also ultimately turned many market leaders into losers.

This message is especially clear to executives whose companies have significantly increased their standings in this year's ELECTRONIC BUSINESS 200. Of the top 200 electronics companies ranked annually by this magazine, 93 firms advanced on the list this year over positions they previously held, and 21 companies joined this list.

"Profits are our No. 1 concern; size is way down the list," says Paul Eder, senior vice president of Anthem Electronics Inc., a leading distributor. "We would rather be a profitable midsized company than a large also-ran." This year, Anthem rose 32 slots on the ELECTRONIC BUSINESS 200 —to No. 166.

Eder echoes the sentiments of many executives. Indeed, in 1987 the industry's top performers kept both eyes sharply focused on the bottom line. As a result, total net income for the 200 leaders rose more than 50% to \$41 billion after two years of declining growth, according to the ELECTRONIC BUSINESS 200. Electronics sales, by comparison, grew 7% to \$299.2 billion for the calendar year. Since 1983, sales have risen 10.7% compounded annually. Net income, meanwhile, has increased 13.9% a year during the five years. ▸

ELECTRONIC BUSINESS 200

FINANCE

The ELECTRONIC BUSINESS 200 is an exclusive report by ELECTRONIC BUSINESS magazine analyzing the financial statements of the 200 largest United States-based computer and electronics manufacturers. It is based on a careful analysis of hundreds of annual reports, 10-K Reports, interviews with company executives and estimates developed internally at the magazine. As such, the 200 — which only includes publicly held companies — provides an accurate gauge of the current status and future direction of the U.S. electronics industry.

And the prognosis is good. After spending two years streamlining operations, many of the ELECTRONIC BUSINESS 200 are well positioned for steady growth. And those that aren't are rapidly moving in that direction (see accompanying story). To see what the successful ones are doing right, ELECTRONIC BUSINESS closely studied the strategies of companies that vastly improved their standings

in the ELECTRONIC BUSINESS 200 between 1986 and 1987.

For example, workstation maker Sun Microsystems Inc., with the largest sales growth rate this year, moved up 28 spots to No. 65. And Mark IV Industries Inc., a diversified manufacturer of industrial products — and next fastest growing — jumped 64 positions on our listing — to spot 116. Along the way, however, these companies didn't blindly sacrifice profits at the altar of revenue. Indeed, Sun's net income nearly doubled in 1987, while Mark IV's climbed to almost 80%. "Our goal is to repeat what we have done well, learn from our mistakes and produce real returns at the operating unit level of a minimum of 15% of sales," says Sal H. Alfiero, Mark IV chairman.

Not by chance

Growth like this doesn't happen by chance. Rather, the winners have carefully orchestrated their successes

Key to that success is implementation of strict financial controls and an emphasis on profits.

"It takes strong concentration to focus on specific products or niches with profit potential when most of the competition is chasing sales volume," says Jerry Kalov, president of Dynascan Corp., a Chicago consumer electronics company that went from a \$17 million loss from continuing operations in 1984 to a \$6.6 million profit in 1987. "But if a product doesn't make a profit, we won't sell it." While that may seem obvious, many electronics companies owe their demise to aggressive marketing of products for all the wrong reasons — merely to expand their product lines, for example, or to get into new market segments without regard for profit potential.

No longer. In 1987, the emphasis on the bottom line forced many companies to completely rethink their corporate philosophies. While strate-

Composite performance of the ELECTRONIC BUSINESS 200

	1983	1984	Percentage change	1985	Percentage change	1986	Percentage change	1987	Percentage change
Electronic sales (\$ billions)	\$225.9	\$256.2	+13.4%	\$267.8	+4.5%	\$279.2	+4.3%	\$299.2	+7.2%
Total sales (\$ billions)	\$732.5	\$776.5	+6.0%	\$797.8	+2.7%	\$641.7	-19.6%	\$689.7	+7.5%
Net income (\$ billions)	\$37.4	\$46.4	+24.1%	\$35.4	-23.7%	\$25.7	-24.6%	\$41.0	+53.6%
Weighted averages:									
Return on equity	13.8%	16.5%	—	11.8%	—	10.2%	—	14.1%	—
Return on investment	10.2%	12.6%	—	8.7%	—	7.2%	—	10.1%	—
Cost of goods sold as a percentage of sales	70.0%	69.4%	—	70.3%	—	63.7%	—	61.5%	—
R&D as a percentage of sales	4.1%	4.2%	—	4.2%	—	5.0%	—	5.2%	—
Sales per employee	\$97,300	\$103,200	+6.1%	\$110,800	+7.4%	\$102,348	-7.6%	\$113,533	+10.9%
Net income per employee	\$5,100	\$6,300	+23.5%	\$5,000	-20.6%	\$4,266	-14.7%	\$6,662	+56.2%
5-year compound growth:									
Sales	+8.5%	+8.5%	—	+5.0%	—	+8.2%	—	+10.7%	—
Net income	+7.3%	+11.6%	—	+1.4%	—	+4.0%	—	+13.9%	—
Capital outlay to net cash flow after dividends	89.8%	96.0%	—	118.3%	—	97.9%	—	73.9%	—
Debt as a percentage of total capital	26.1%	23.5%	—	26.7%	—	29.9%	—	28.2%	—
Foreign sales as a percentage of sales	—	—	—	14.0%	—	25.4%	—	24.9%	—

gies vary from company to company, some clear patterns emerged among the winners. Fast-track managers tend to implement a combination of the following practices, tailoring their strategy to fit the individual needs of their companies. To continue to increase profits and revenue in an uncertain business climate, they have:

- Held tight reins on inventories
- Spread risk through diversification
- Expanded international sales and operating bases
- Consolidated manufacturing and trimmed workforces
- Pruned unprofitable or extraneous businesses
- Added product lines through internal development, joint ventures or acquisitions.

In some cases, firms vastly increased their size and ELECTRONIC BUSINESS 200 ranking largely by devouring new companies and adding sales to the corporate total. Computer and video-game manufacturer Atari Corp., for example, acquired the Federated Group Inc., a consumer electronics retail chain for \$64 million. It is also seeking to acquire a semiconductor facility or, at least, to form an alliance with a chip company. And West Amherst, New York-based Mark IV purchased diversified Conrac Corp., for \$185 million; and the Eagle Signal Controls Division of Wickes, for \$16 million. In keeping with its strategy to manufacture only proprietary products, Mark IV at the same time got rid of its Engineered Magnetics business and its polystyrene and rubber-producing plants.

Strategic fit

San Jose-based Anthem expanded to the Northeast with the purchase of distributor Lionex Corp. And Olin Corp., Stamford, Conn., bought Aegis Inc., a supplier to the hybrid microelectronics industry, while divesting its firearm manufacturing business, among others. "Focusing on profit detractors continues to be a major strategic emphasis," says John W. Johnstone Jr., president of the Stamford, Conn., electronic materials and services, metals and chemicals company. "The issue of strategic fit must be addressed. There are no sacred cows at Olin."

The stepped-up pace of mergers and acquisitions in the electronics sector is also expected to continue. Dynascan, for one, intends to each

year buy a company worth more than \$25 million. In 1987, it completed the acquisition of Marantz Co., transforming the faltering audio equipment maker into a profitable business. The same year, Dynascan also sold off its industrial control and test equipment operations to concentrate solely on consumer electronics.

Despite Wall Street's generally negative attitude toward consumer electronics, Dynascan believes it can be a gold mine for those with the right strategy. "It's a terrific place to grow profitably by following selective nichemanship," says Kalov. For Dynascan, that "nichemanship" means never being a pioneer and never going up against the giants. "We do not want to be first; that requires substantial investment," explains Kalov. "We prefer to watch the market develop, begin to mature and learn from the mistakes of others." Dynascan's products include Cobra brand telephones, auto radar detectors, CB

radios, stereo equipment and facsimile machines.

Nichemanship

These days, nichemanship can mean the difference between winning and losing. LSI Logic Corp., Milpitas, Calif., is betting that by transforming into an application-specific integrated circuit systems supplier it will cash in on the fast-growing ASIC business in the 1990s.

Mark IV, meanwhile, has targeted small industrial markets, from \$20 million to \$250 million, thus enabling them to steer clear of the giants. Also, says Alfiero, "the markets we pursue have significant technical and financial thresholds which may reduce the number of small competitors." Mark IV's businesses include everything from microprocessor controls to professional sound systems to telephone answering machines.

Niches don't have to be small, off-the-beaten-track segments. ▸

Can't tell an annual report by its cover

"Changing for the future," announces Cincinnati Milacron Inc. in big, bold red letters on the somber gray cover of its 1987 annual report. NBI Inc., meanwhile, declares: "Change equals opportunity" on the front of its latest report. Indeed, for those firms whose ELECTRONIC BUSINESS 200 standing dropped dramatically last year, change is indeed the name of the game.

In face of sales downturns, troubled companies dramatically restructured operations. They shut down or sold businesses, took painful writeoffs, trimmed workforces, brought in new managers and hoped for the best. "What we did in 1987 was demonstrate our ability to change," says Gary K. Willis, president of Foxboro Inc., a Foxboro, Mass., manufacturer of process control equipment.

GenRad Inc., a Concord, Mass. producer of test and measurement systems, closed the doors of its Semiconductor Test Division, which made high-end VLSI test systems. The cost: \$32.5 million. Cleveland-based Eaton Corp.

started selling its defense operations. Penn Central Corp., Cincinnati maker of telecommunications, defense and energy products, spun off its Sprague Technologies Inc. electronics businesses. And BRIntec Corp. put its printed circuit board and specialty telephone equipment businesses on the block.

"Restructuring actions were initiated as a strategic response to economic, technological and competitive changes," says Peter Petruchik, president of BRIntec, a Willimantic, Conn., maker of connectors and cable. BRIntec and other survivors of painful restructuring are predicting increased sales and profits in coming years. "We expect earnings growth averaging 12% to 15% a year and return on equity exceeding 20%," predicts Petruchik.

These new, leaner companies don't intend to get caught short again. "Restructuring can never be considered an accomplished fact," says Foxboro's Willis. "It must remain a dynamic process calculated to challenge our performance on a continuing basis." He adds: "The major efforts are behind us."

Compaq Computer Corp., for example, went up against no less of a giant than IBM with commodity products — and managed to surpass \$1 billion in sales and \$135 million in profits after only five years. Its niche is IBM-clone computers. Indeed, Compaq has become one of the industry's most remarkable success stories by beating IBM at its own game. Houston-based Compaq offers the same technology for less money and also steps in to fill the gaps when IBM leaves a market. By the end of 1987, boasts Rod Canion, Compaq president, "we emerged as a leader in high performance, industry-standard products worldwide."

Being a global leader is increasingly important. LSI Logic's international revenue, for example, last year grew twice as fast as total corporate revenue. And, says James M. McCoy, president of Maxtor Corp., San Jose: "Strengthening our position as a leading factor in the worldwide data storage marketplace is our primary goal." In 1987, the 5-year-old high-capacity disk maker broke ground for a new facility in Singapore and opened its first international direct sales office in Britain. "Boosted particularly by growth in Western Europe, international sales reached nearly \$28 million, 16% of total revenues," according to McCoy.

Global leader

Atari, meanwhile, opened sales subsidiaries in Sweden, Spain, Australia and Mexico. The formerly beleaguered electronic game manufacturer has, under the leadership of Jack Tramiel, chairman, become a respected player in international markets for a variety of computer products, software and peripherals. Even its original video game line is making a comeback. Net sales outside North America accounted for 46% of total sales in 1987.

Atari UK reportedly has secured a 40% share of the 16-bit personal computer market in Great Britain. West Germany's Supreme Court keeps track of volumes of courtroom precedents and trial verdicts on Atari equipment. And in France, jazz artist Jean Michel Jarre composes on his Atari ST, taking advantage of Atari's musical instrument digital interface ports that allow musicians to connect synthesizers and instruments to their computers. "Our commitment to an

international marketing strategy has resulted in a dramatic increase in European sales," says Tramiel. In fact, he says, European demand for Atari's new personal computers rose so sharply last year the firm was forced to postpone its marketing assault in the United States.

For the ELECTRONIC BUSINESS 200

For two straight years, foreign sales accounted for 25% of the 200's total revenue

as a whole, foreign sales accounted for about 25% of total corporate sales, about the same as last year but up dramatically from 14% two years ago. In many cases, unit sales growth was higher, but losses resulting from the weak dollar in many markets shrouded real growth.

Having a worldwide base not only moves engineering and manufactur-

ing operations closer to customers, it also enables a company to compensate for a cyclical downturn in one geographical area with sales to another, economically stronger location. "Being global makes us less vulnerable to protectionism and it shields us, in part at least, from the effect of swings in currency values," says T. Kevin Dunnigan, president of components maker Thomas & Betts Corp. "Becoming truly multinational is a complex problem, but the long-term advantages make the effort worthwhile."

Those long-term advantages will be most noticeable on a firm's bottom line. And as the electronics industry grows from the wild child of the early years to the mature industry of the 1990s, the bottom line will continue to be the most important consideration. Mark IV chairman Alfiero spoke for many successful electronics executives in outlining his firm's objectives: "Our goals are to strengthen our balance sheet, to work with our existing operations to enhance profitability and to watch for opportunities to expand and excel." □

Notes to the 200

Revenue

Revenue includes sales of products, services and rentals, but excludes dividends, interest and other nonoperating revenue.

Profit

Profits are shown after taxes from continuing operations and before extraordinary items.

Return on equity

ROE is profits as a percentage of shareholders' equity — preferred stock, capital stock, surplus and retained earnings at year-end.

Return on investment

ROI is profits as a percentage of shareholders' equity plus short- and long-term debt. Short-term debt includes the current portion of long-term debt, notes payable and other borrowings.

Cost of goods sold

This includes manufacturing costs of products, services and rentals sold, less depreciation.

Research and development

R&D is company-sponsored research and development expenses as a percentage of revenue.

Employees

The number of employees is supplied by each company. In most cases this number represents year-end employment.

Capital expenditures

to net cash flow
Capital expenditures are measured as a percentage of net profits plus depreciation, minus cash dividends paid.

Debt to total capital

This includes long-term debt plus short-term debt as a percentage of shareholders' equity and long- and short-term debt.

Foreign sales

These include sales of operations outside the United States to unaffiliated customers and U.S. operations' export sales.

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES

Ranking: 1 - 50

		Calendar year 1987			Fiscal year 1987			Return on equity	Return on investment
Rank 1987	Rank 1986	Company	Electronics revenue (\$ millions)	Total revenue (\$ millions)	Net income (\$ millions)	Total revenue (\$ millions)	Net income (\$ millions)		
1	1	IBM	\$54,217.0	\$54,217.0	\$5,258.0	\$54,217.0	\$5,258.0	13.7%	12.0%
2	2	AT&T	16,062.0	33,598.0	2,044.0	33,598.0	2,044.0	14.1%	9.1%
3	4	GM Hughes Electronics	10,481.0	10,481.0	521.1	10,481.0	521.1	7.4%	6.7%
4	5	Digital Equipment	10,391.1	10,391.1	1,284.2	9,389.4	1,137.4	18.1%	17.3%
5	7	Unisys	9,712.9	9,712.9	578.0	9,712.9	578.0	12.7%	8.7%
6	3	General Electric	9,514.0	39,315.0	2,915.0	39,315.0	2,119.0	12.9%	9.6%
7	6	Xerox	8,980.0	10,320.0	578.0	10,320.0	578.0	10.4%	7.5%
8	8	Hewlett-Packard	8,542.0	8,542.0	707.0	8,090.0	644.0	12.8%	10.6%
9	11	Motorola	6,707.0	6,707.0	308.0	6,707.0	308.0	10.2%	8.3%
10	12	Honeywell	6,679.3	6,679.3	253.7	6,679.3	253.7	11.3%	7.0%
11	14	NCR	5,640.7	5,640.7	419.3	5,640.7	419.3	19.4%	17.7%
12	13	Texas Instruments	5,594.5	5,594.5	256.9	5,594.5	256.9	11.4%	9.2%
13	10	Lockheed	5,211.6	11,321.0	436.0	11,321.0	436.0	20.9%	7.2%
14	15	Raytheon	4,740.0	7,659.4	445.1	7,659.4	445.1	24.1%	19.0%
15	17	Eastman Kodak	4,435.0	13,305.0	1,178.0	13,305.0	1,178.0	19.6%	14.3%
16	16	Rockwell International	4,423.7	11,936.5	678.6	12,123.4	635.1	19.2%	15.0%
17	19	Tandy	3,654.7	3,654.7	289.8	3,452.2	242.3	17.6%	15.3%
18	9	Allied-Signal	3,380.0	11,116.0	515.0	11,116.0	515.0	16.5%	9.1%
19	20	TRW	3,192.0	6,821.0	243.0	6,821.0	243.0	17.1%	9.4%
20	23	Litton Industries	3,191.7	4,735.5	151.3	4,419.7	138.1	13.1%	10.8%
21	22	Wang Laboratories	3,047.6	3,047.6	94.5	2,836.7	70.7	4.8%	3.1%
22	31	Apple Computer	3,041.3	3,041.3	280.4	2,661.1	217.5	26.0%	26.0%
23	28	Martin Marietta	2,960.2	5,165.1	230.7	5,165.1	230.7	25.4%	18.3%
24	26	Ford Motor	2,786.9	71,643.4	4,625.2	71,643.4	4,625.2	25.1%	21.0%
25	25	3M	2,698.0	9,429.0	918.0	9,429.0	918.0	18.1%	15.9%
26	21	Control Data	2,667.5	3,366.5	21.5	3,366.5	25.0	2.4%	1.7%
27	27	ITT	2,662.6	19,525.0	1,018.0	8,551.0	1,018.1	13.0%	9.5%
28	24	Westinghouse Electric	2,563.0	10,679.0	738.9	10,679.0	738.9	20.7%	12.4%
29	34	Zenith Electronics	2,362.7	2,362.7	-19.1	2,362.7	-19.1	-4.0%	-2.1%
30	29	Harris	2,100.1	2,100.1	92.2	2,079.0	84.5	8.6%	7.4%
31	36	Pitney Bowes	2,009.2	2,250.5	199.4	2,250.5	199.4	19.2%	13.5%
32	37	Du Pont	2,000.0	30,468.0	1,786.0	30,468.0	1,786.0	12.5%	9.4%
33	33	Boeing	1,980.0	15,355.0	480.0	15,355.0	480.0	9.6%	9.1%
34	40	AMP	1,912.0	2,317.8	249.7	2,317.8	249.7	18.5%	16.3%
35	48	Intel	1,907.1	1,907.1	175.5	1,907.1	175.5	13.4%	8.5%
36	39	National Semiconductor	1,877.7	1,877.7	-28.8	1,867.9	-28.8	-3.2%	-2.9%
37	38	McDonnell Douglas	1,810.0	13,344.5	313.0	13,344.5	313.0	10.5%	6.9%
38	32	GTE	1,784.2	15,421.0	1,118.8	15,421.0	1,082.0	11.3%	5.4%
39	45	Emerson Electric	1,770.0	6,317.5	482.8	6,170.3	467.2	17.3%	12.9%
40	41	Singer	1,618.0	1,902.7	23.4	1,902.7	23.4	3.7%	1.5%
41	52	Amdahl	1,505.2	1,505.2	142.0	1,505.2	142.0	18.1%	15.4%
42	47	Avnet	1,482.0	1,670.7	37.3	1,547.1	22.8	3.5%	2.6%
43	42	United Technologies	1,420.0	17,170.2	591.7	17,170.2	591.7	10.3%	7.2%
44	44	Tektronix	1,388.9	1,388.9	25.7	1,395.9	51.2	6.1%	5.7%
45	46	Data General	1,303.9	1,303.9	-75.9	1,274.3	-82.9	-14.1%	-11.7%
46	50	Perkin-Elmer	1,233.0	1,377.8	-9.6	1,333.6	-18.2	-2.6%	-2.0%
47	69	Compaq Computer	1,224.1	1,224.1	136.3	1,224.1	136.3	34.1%	24.8%
48	43	Teledyne	1,222.0	3,216.8	377.2	3,216.8	377.2	19.1%	14.9%
49	49	Northrop	1,124.5	6,052.5	94.2	6,052.5	94.2	9.9%	5.0%
50	57	General Instrument	1,104.0	1,104.0	53.6	787.9	18.5	4.0%	2.8%

NA = not available

NM = not meaningful

Cost of goods as a percentage of revenue	Fiscal year 1987			Five-year growth (Compounded average annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee (\$ thousands)	Net income per employee (\$ thousands)	Revenue	Net income				
38.9%	10.0%	\$139.3	\$13.5	9.5%	3.6%	70.2%	12.5%	54.0%	12/87
38.2%	7.3%	110.9	6.7	NA	NA	82.3%	35.2%	NA	12/87
72.3%	4.0%	104.8	5.2	NA	NA	56.1%	9.7%	11.6%	12/87
22.3%	10.8%	85.0	10.3	19.3%	22.2%	47.6%	4.2%	47.0%	6/87
32.5%	6.1%	105.0	6.2	18.9%	33.4%	75.4%	31.6%	43.6%	12/87
71.5%	3.1%	130.2	7.0	7.7%	3.4%	71.5%	25.4%	23.4%	12/87
45.1%	7.0%	104.2	5.8	5.3%	47.8%	97.3%	27.9%	44.9%	12/87
42.6%	11.1%	98.7	7.9	14.1%	11.0%	54.8%	17.5%	49.0%	10/87
53.2%	7.8%	68.6	3.2	12.1%	12.6%	91.5%	19.4%	43.8%	12/87
66.8%	4.3%	84.7	3.2	11.3%	6.6%	53.0%	38.4%	20.6%	12/87
48.8%	6.3%	91.0	6.8	9.9%	12.4%	62.4%	9.0%	54.6%	12/87
71.5%	7.7%	71.7	3.3	5.3%	12.3%	82.0%	19.7%	31.5%	12/87
89.7%	4.8%	114.0	4.4	15.1%	16.1%	53.9%	65.5%	8.0%	12/87
76.9%	3.5%	100.1	5.8	8.0%	8.0%	64.6%	21.1%	17.1%	12/87
52.7%	7.5%	107.0	9.5	4.2%	0.3%	103.2%	26.9%	42.8%	12/87
74.8%	3.5%	104.4	5.5	10.4%	13.9%	50.2%	21.6%	15.1%	9/87
47.4%	0.0%	88.5	6.2	13.5%	1.6%	34.3%	12.6%	1.6%	6/87
77.0%	6.0%	96.4	4.5	17.8%	12.9%	108.6%	44.6%	19.3%	12/87
73.1%	4.8%	87.6	3.1	8.9%	7.4%	100.0%	45.4%	25.7%	12/87
76.1%	4.7%	81.5	2.5	2.1%	-14.0%	84.7%	17.7%	22.7%	7/87
27.1%	7.5%	93.6	2.3	19.6%	-8.0%	42.8%	33.8%	40.1%	6/87
46.1%	7.2%	475.2	38.8	35.5%	28.8%	31.6%	0.0%	27.1%	9/87
76.5%	4.3%	73.8	3.3	11.2%	16.9%	77.9%	27.9%	NA	12/87
77.2%	3.5%	204.5	13.2	14.1%	NM	51.7%	16.5%	NA	12/87
52.5%	6.6%	115.0	11.2	7.4%	7.8%	77.9%	12.1%	39.8%	12/87
63.3%	11.6%	97.6	0.7	1.1%	-30.6%	73.8%	29.6%	20.0%	12/87
77.4%	2.2%	71.3	8.5	-11.7%	7.7%	37.2%	27.2%	52.4%	12/87
70.3%	2.0%	94.9	6.6	1.8%	10.5%	51.0%	39.8%	20.6%	12/87
83.7%	4.4%	67.5	-0.5	13.8%	NM	247.3%	47.7%	17.2%	12/87
58.8%	5.7%	85.6	3.5	4.8%	1.1%	39.7%	13.8%	14.7%	6/87
31.7%	2.9%	76.4	6.8	10.0%	17.5%	88.9%	29.5%	19.5%	12/87
49.0%	4.0%	217.4	12.7	1.0%	14.8%	100.1%	25.0%	49.8%	12/87
84.8%	5.4%	112.8	3.5	11.2%	10.5%	96.2%	5.1%	40.9%	12/87
56.8%	8.8%	105.4	11.3	13.3%	16.0%	57.6%	12.2%	52.3%	12/87
45.7%	13.6%	99.3	9.1	16.2%	42.4%	86.9%	36.5%	38.8%	12/87
62.1%	11.7%	64.0	-1.0	11.1%	NM	79.2%	11.3%	42.1%	5/87
76.7%	4.9%	118.7	2.8	12.5%	7.8%	86.9%	34.9%	21.4%	12/87
41.3%	1.6%	95.8	6.7	6.0%	5.9%	116.4%	52.1%	13.3%	12/87
62.8%	3.1%	89.8	6.8	10.1%	7.6%	29.3%	25.3%	20.0%	9/87
92.2%	2.0%	68.0	0.8	9.0%	-18.6%	109.5%	60.0%	NA	12/87
47.8%	11.9%	198.0	18.7	26.6%	96.1%	66.2%	17.1%	44.3%	12/87
73.5%	0.0%	162.8	2.4	6.8%	-16.5%	146.5%	25.7%	NA	6/87
73.2%	5.1%	90.4	3.1	6.5%	5.3%	156.2%	29.4%	24.5%	12/87
39.8%	14.3%	81.6	7.0	3.1%	-6.7%	49.5%	6.0%	42.2%	5/87
47.8%	12.5%	81.2	-5.3	9.6%	NM	576.1%	16.8%	45.0%	9/87
52.6%	10.5%	94.5	-1.3	5.2%	NM	492.2%	22.8%	46.2%	7/87
56.8%	3.8%	306.0	34.1	NA	NA	71.4%	27.2%	26.0%	12/87
73.5%	2.7%	72.5	8.5	-3.6%	6.9%	19.2%	21.8%	7.9%	12/87
94.4%	2.7%	125.6	2.0	19.6%	79.9%	103.4%	49.3%	NA	12/87
76.5%	3.1%	48.3	1.1	-2.9%	-28.1%	103.7%	29.4%	16.2%	2/87

Source: ELECTRONIC BUSINESS

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES

Ranking: 51-100

		Calendar year 1987			Fiscal year 1987				
Rank 1987	Rank 1986	Company	Electronics revenue (\$ millions)	Total revenue (\$ millions)	Net income (\$ millions)	Total revenue (\$ millions)	Net income (\$ millions)	Return on equity	Return on investment
51	53 *	Grumman	\$1,089.5	\$3,375.3	\$27.1	\$3,375.3	\$27.1	1.8%	1.2%
52	60	Tandem Computers	1,079.7	1,079.7	102.2	1,035.5	105.6	14.6%	14.4%
53	66	Seagate Technology	1,075.7	1,075.7	115.3	958.1	139.7	39.5%	21.3%
54	51	E-Systems	1,067.2	1,227.2	60.4	1,227.2	60.4	14.1%	11.8%
55	55	General Dynamics	1,050.0	9,344.0	437.3	9,344.0	437.3	27.3%	21.6%
56	56	Varian Associates	1,032.9	1,032.9	-4.1	982.8	21.4	4.9%	4.1%
57	71	Advanced Micro Devices	997.1	997.1	-48.1	997.1	-48.1	-7.3%	-6.0%
58	58	Prime Computer	960.9	960.9	64.8	960.9	64.8	12.9%	6.1%
59	59	Chrysler	946.0	26,276.5	1,289.7	26,276.5	1,289.7	19.8%	12.7%
60	53	Gould	933.4	933.4	25.0	933.4	25.0	5.2%	3.0%
61	68	Loral	920.0	1,244.7	69.6	690.0	57.5	15.8%	13.6%
62	61	Johnson Controls	811.0	2,806.8	96.6	2,676.8	89.6	11.6%	8.2%
63	63	Emerson Radio	792.4	792.4	-9.8	810.1	26.6	27.7%	9.0%
64	35	Eaton	775.0	3,137.9	206.2	3,137.9	206.2	19.2%	10.8%
65	93	Sun Microsystems	755.9	755.9	48.0	537.5	36.3	15.1%	9.0%
66	67	Storage Technology	750.0	750.0	19.0	750.0	19.0	8.1%	3.1%
67	70	SmithKline Beckman	704.1	4,328.8	570.1	4,328.8	570.1	36.0%	20.4%
68	73	Cray Research	687.3	687.3	147.1	687.3	147.1	24.1%	20.2%
69	54	Contel	660.0	2,905.5	77.7	2,905.5	77.7	5.4%	2.1%
70	64	General Signal	641.2	1,603.0	69.4	1,603.0	69.4	7.6%	6.8%
71	72	Intergraph	641.1	641.1	69.9	641.1	69.9	12.3%	12.2%
72	77	Monsanto	634.0	7,639.0	436.0	7,639.0	436.0	11.2%	7.3%
73	80	SCI Systems	614.7	614.7	17.0	552.9	16.0	12.0%	5.0%
74	—	Computer Associates	604.7	604.7	79.2	309.3	36.5	16.6%	11.1%
75	79	Computervision ¹	564.0	564.0	19.5	564.0	19.5	NA	NA
76	89	Western Digital	563.1	563.1	44.5	462.5	42.8	21.2%	-20.3%
77	78	Arrow Electronics	562.4	562.4	-15.8	562.4	-15.8	-16.4%	-10.0%
78	86	Apollo Computer	553.7	553.7	21.7	553.7	21.7	9.6%	6.3%
79	85	Medtronic	537.0	608.0	83.5	502.0	73.8	19.1%	17.4%
80	74	Corning Glass Works	522.0	2,083.7	203.3	2,083.7	203.3	13.2%	10.3%
81	81	Scientific-Atlanta	513.9	513.9	28.4	495.3	24.3	12.0%	11.6%
82	115	Atari	493.2	493.2	44.2	493.2	44.2	26.3%	14.2%
83	82	United Telecommunications	476.3	2,982.2	-51.5	2,982.2	-51.5	-3.3%	-1.1%
84	88	Tyler	475.4	1,099.5	16.8	1,099.5	16.8	9.4%	5.8%
85	84	Xidex	460.0	579.7	-9.2	572.8	-44.5	-11.5%	-8.4%
86	114	Microsoft	456.7	456.7	92.9	345.9	71.9	30.1%	29.2%
87	—	Raychem	447.2	1,016.4	89.8	944.4	73.6	12.9%	10.5%
88	75	M/A-COM	437.3	437.3	-27.3	436.1	-29.3	-10.9%	-7.5%
89	—	Sprague Technologies	437.3	437.3	3.6	437.3	3.6	1.1%	1.0%
90	91	Molex	437.1	437.1	50.2	386.8	43.4	13.7%	13.3%
91	96	EG&G	420.4	1,247.5	55.5	1,247.5	55.5	20.4%	15.7%
92	83	Textron	410.0	5,388.4	261.1	5,388.4	261.1	11.3%	6.9%
93	116	LTV	396.0	7,581.8	502.6	7,581.8	502.6	-24.6%	-25.0%
94	106	Lotus Development	395.6	395.6	72.0	395.6	72.0	35.7%	30.0%
95	131	Wyse Technology	392.8	392.8	25.4	260.0	18.1	19.6%	18.2%
96	119	Emhart	392.0	2,454.5	106.5	2,454.5	106.5	12.7%	7.6%
97	95	Analog Devices	390.7	390.7	22.3	370.4	18.7	6.1%	5.6%
98	101	Convergent	384.8	384.8	-26.5	384.8	-26.5	-13.7%	-12.3%
99	100	Teradyne	377.7	377.7	-21.5	377.7	-21.5	-7.7%	-6.5%
100	92	Compugraphic	367.1	367.1	10.1	367.1	10.1	5.1%	4.0%

* 1986 rank readjusted

NA = not available

¹ bought by Prime Feb. 12, 1988

NM = not meaningful

Cost of goods as a percentage of revenue	Fiscal year 1987			Five-year growth (Compounded average annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee (\$ thousands)	Net income per employee (\$ thousands)	Revenue	Net income				
89.4%	1.4%	\$100.2	\$0.8	10.4%	-21.4%	187.8%	34.2%	9.3%	12/87
29.6%	10.5%	147.8	15.1	27.1%	0.0%	90.3%	1.4%	44.4%	9/87
68.6%	3.5%	59.9	8.7	38.3%	82.5%	46.8%	46.1%	43.6%	6/87
81.4%	2.7%	79.1	3.9	11.8%	8.2%	68.3%	16.1%	6.6%	12/87
78.9%	3.6%	88.7	4.2	9.7%	20.7%	48.9%	21.1%	NA	12/87
65.0%	8.2%	82.6	1.8	8.4%	-3.0%	87.3%	16.6%	23.6%	9/87
41.1%	24.9%	55.3	-2.7	19.5%	NM	141.8%	17.7%	27.2%	12/87
38.2%	11.4%	109.0	7.3	17.1%	7.6%	69.0%	52.3%	48.0%	12/87
77.7%	3.0%	186.4	9.1	21.2%	NM	65.8%	35.8%	9.9%	12/87
49.4%	10.1%	92.2	2.5	4.0%	-17.2%	51.2%	42.2%	38.0%	12/87
73.9%	4.6%	47.6	4.0	19.6%	17.2%	45.9%	13.9%	6.2%	3/87
76.4%	1.8%	99.5	3.3	16.4%	10.7%	70.0%	29.6%	14.4%	9/87
88.1%	0.1%	1,012.6	33.3	56.0%	145.2%	14.6%	67.4%	NA	3/87
68.0%	3.7%	87.4	5.7	7.2%	NM	58.6%	43.6%	22.7%	12/87
46.1%	12.9%	128.5	8.7	474.4%	NM	124.0%	40.5%	32.0%	6/87
59.5%	8.0%	84.6	2.1	-7.0%	-21.8%	183.5%	61.7%	26.4%	12/87
31.0%	9.8%	119.2	15.7	10.4%	4.6%	29.6%	43.3%	38.1%	12/87
11.4%	15.8%	159.5	34.1	37.2%	50.6%	18.3%	16.1%	37.0%	12/87
30.2%	0.0%	133.8	3.6	8.0%	-11.3%	173.6%	60.8%	NA	12/87
61.3%	6.6%	83.8	3.6	-0.2%	-8.4%	42.1%	11.5%	20.9%	12/87
45.1%	10.5%	101.8	11.1	32.7%	40.0%	44.8%	1.0%	36.9%	12/87
53.4%	8.1%	153.6	8.8	3.8%	5.8%	55.9%	35.0%	NA	12/87
93.0%	0.0%	83.0	2.4	43.8%	31.3%	104.8%	58.3%	24.8%	6/87
-8.8%	13.0%	114.6	13.5	48.3%	65.8%	16.4%	32.8%	48.7%	3/87
NA	NA	NA	NA	11.6%	-9.7%	NA	NA	NA	12/87
59.3%	8.1%	138.5	12.8	69.2%	43.2%	66.7%	4.1%	36.9%	6/87
79.4%	0.0%	308.0	-8.7	5.8%	NM	-13.0%	39.5%	0.0%	12/87
44.5%	11.0%	138.4	5.4	98.2%	135.4%	84.3%	34.2%	51.8%	12/87
28.4%	8.4%	101.4	14.9	11.9%	8.7%	32.3%	8.8%	41.5%	4/87
60.6%	4.8%	81.7	8.0	5.7%	22.2%	76.6%	22.3%	31.3%	12/87
69.0%	4.1%	147.9	7.2	8.0%	11.4%	18.9%	3.5%	0.2%	6/87
60.8%	3.7%	120.6	10.8	19.1%	16.2%	8.4%	46.2%	45.9%	12/87
-18.9%	0.0%	127.9	-2.2	4.3%	NM	218.9%	67.1%	NA	12/87
74.8%	0.0%	146.6	2.2	11.0%	13.0%	76.5%	38.4%	NA	12/87
76.7%	2.0%	83.0	-6.5	42.6%	NM	-150.0%	26.7%	29.9%	6/87
19.2%	11.0%	190.5	39.6	69.8%	83.0%	73.0%	2.9%	42.3%	6/87
42.0%	7.3%	95.4	7.4	12.0%	14.6%	65.7%	18.8%	61.6%	6/87
69.0%	5.6%	64.6	-4.3	4.5%	NM	-295.1%	31.4%	21.5%	6/87
74.1%	4.8%	50.8	0.4	NA	NA	76.2%	5.1%	38.2%	12/87
46.2%	5.5%	77.9	8.7	18.4%	16.0%	65.2%	3.3%	68.4%	6/87
78.9%	1.4%	55.4	2.5	8.3%	6.9%	29.8%	22.9%	7.1%	12/87
78.5%	2.2%	88.3	4.3	22.1%	30.6%	65.3%	39.2%	27.5%	12/87
81.7%	0.0%	157.3	10.4	9.7%	26.5%	45.7%	-1.5%	NA	12/87
13.4%	14.8%	188.4	34.3	356.3%	NM	30.3%	15.7%	52.3%	12/87
66.4%	5.3%	128.7	9.0	102.7%	NM	36.8%	7.5%	0.2%	3/87
64.5%	1.6%	8.0	3.5	7.5%	5.8%	64.7%	40.2%	40.9%	12/87
37.3%	15.1%	71.2	3.6	16.3%	13.6%	82.1%	8.3%	0.5%	10/87
59.1%	8.7%	114.9	-7.9	24.8%	NM	-600.3%	10.2%	17.0%	12/87
50.2%	16.3%	80.4	-4.6	12.8%	NM	374.1%	15.9%	36.4%	12/87
45.0%	10.9%	88.7	2.4	5.6%	4.5%	90.3%	20.7%	28.9%	12/87

Source: ELECTRONIC BUSINESS

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES

Ranking: 101-150

		Calendar year 1987			Fiscal year 1987			Return on equity	Return on investment
Rank 1987	Rank 1986	Company	Electronics revenue (\$ millions)	Total revenue (\$ millions)	Net income (\$ millions)	Total revenue (\$ millions)	Net income (\$ millions)		
101	158	MiniScribe	\$362.5	\$362.5	\$28.1	\$362.5	\$28.1	27.8%	14.0%
102	111	Dover	360.6	1,585.5	111.7	1,585.5	111.7	16.6%	13.1%
103	94	Diebold	360.0	439.1	35.8	439.1	35.8	10.5%	10.3%
104	105	Dynatech	348.9	348.9	21.4	304.7	23.2	14.8%	13.9%
105	—	LPL Investment ²	347.3	347.3	5.1	347.3	5.1	13.5%	0.9%
106	99	AM International	342.0	1,199.0	1.6	1,162.8	2.3	0.9%	0.4%
107	120	Nashua	341.0	865.1	26.6	865.1	26.6	12.8%	9.5%
108	103	Marshall Industries	340.3	340.3	10.6	286.6	5.1	9.4%	5.1%
109	—	MAI Basic Four	334.3	334.3	23.8	321.0	22.8	29.3%	17.6%
110	90	Dataproducts	334.2	334.2	-3.6	338.8	9.0	4.1%	3.3%
111	126	Polaroid	330.0	1,763.9	116.1	1,763.9	116.1	10.8%	8.9%
112	65	Penn Central	325.0	1,421.4	34.8	1,421.4	34.8	2.1%	1.9%
113	98	Datapoint	320.7	320.7	15.1	312.1	-58.5	-32.2%	-20.1%
114	113	Augat	313.2	313.2	11.5	313.2	11.5	5.4%	4.8%
115	102	DSC Communications	312.4	312.4	14.6	312.4	14.6	6.9%	5.1%
116	180	Mark IV Industries	311.2	394.9	16.2	291.5	10.2	25.3%	3.9%
117	97	Cubic	311.0	357.8	7.7	361.8	7.9	7.1%	4.1%
118	123	Eli Lilly	308.0	3,643.8	410.5	3,643.8	410.5	13.5%	11.3%
119	174	Gancom	302.2	302.2	12.6	302.2	12.6	21.5%	7.5%
120	110	Premier Industrial	296.0	486.8	56.0	459.0	48.3	18.1%	17.6%
121	—	Westmark International	291.9	291.9	-7.2	291.9	-7.2	-3.2%	-3.1%
122	168	AST Research	289.8	289.8	8.3	206.0	13.0	13.1%	13.1%
123	127	Tandon	289.1	289.1	17.1	289.1	17.1	18.3%	15.2%
124	138	Micropolis	288.3	288.3	27.2	288.3	27.2	19.6%	12.7%
125	148	Bolt Beranek and Newman	279.8	279.8	-6.1	233.8	-8.0	-9.4%	-8.7%
126	149	AVX	271.9	271.9	15.8	271.9	15.8	8.5%	4.8%
127	121	Square D	270.5	1,484.2	110.0	1,484.2	110.0	16.2%	12.4%
128	103	TIE/communications	270.2	270.2	-11.1	250.2	-11.1	-6.4%	-5.1%
129	124	Recognition Equipment	269.2	269.2	10.1	264.7	11.2	8.4%	5.6%
130	136	Diasonics	267.6	267.6	15.2	267.6	15.2	14.4%	12.1%
131	104	Foxboro	267.3	504.4	-96.9	504.4	-96.9	-51.5%	-40.1%
132	141	Ashton-Tate	267.3	267.3	43.1	267.3	43.1	24.1%	23.0%
133	108	Savin	267.2	356.3	115.0	356.3	0.1	-0.2%	0.1%
134	129	Figgie International	266.0	1,022.7	49.3	1,022.7	49.3	15.3%	11.0%
135	134	Wyle Laboratories	265.4	368.0	5.8	368.0	5.8	6.5%	4.3%
136	118	Watkins-Johnson	264.3	264.3	17.1	264.3	17.1	14.7%	12.0%
137	151	LSI Logic	262.1	262.1	10.7	262.1	10.7	3.5%	2.2%
138	125	CTS	261.1	261.1	10.5	261.1	10.5	8.3%	6.3%
139	107	Kollmorgen	260.0	301.0	0.3	301.0	0.3	0.4%	0.2%
140	117	Bally Manufacturing	255.0	1,730.1	-6.4	1,730.1	-6.4	-1.1%	-0.3%
141	139	Gerber Scientific	254.8	254.8	28.0	223.9	21.1	13.1%	11.7%
142	133	Cooper Industries	251.0	3,585.8	173.8	3,585.8	173.8	10.9%	6.8%
143	153	Bell Industries	250.0	407.1	4.5	357.1	3.3	3.1%	2.4%
144	157	Hall	242.2	1,054.1	66.3	1,054.1	66.3	16.7%	12.2%
145	184	Maxtor	239.4	239.4	16.1	175.3	22.4	22.0%	10.7%
146	137	Pioneer-Standard	238.5	238.5	4.1	212.2	1.8	6.3%	2.2%
147	194	Applied Magnetics	235.7	235.7	17.5	211.9	14.2	9.5%	9.2%
148	132	Reynolds & Reynolds	234.0	572.1	19.5	562.7	21.2	11.0%	7.1%
149	112	Paradyne	232.6	232.6	-2.6	232.6	-2.6	-1.8%	-1.1%
150	147	Andrew	229.0	229.0	4.2	223.2	3.8	2.5%	2.2%

² acquired Amphenol Corp. from Allied Signal on June 2, 1987

NA = not available

NM = not meaningful

Cost of goods as a percentage of revenue	Fiscal year 1987			Five-year growth (Compounded average annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee (\$ thousands)	Net income per employee (\$ thousands)	Revenue	Net income				
71.3%	5.5%	\$72.9	\$5.7	135.5%	NM	28.2%	49.6%	36.1%	12/87
65.2%	2.9%	90.1	6.3	8.9%	4.5%	28.8%	21.1%	24.0%	12/87
64.6%	3.3%	90.0	7.3	0.5%	-2.9%	29.7%	2.0%	7.0%	12/87
40.8%	9.0%	98.3	7.5	23.7%	30.2%	37.3%	26.3%	25.4%	3/87
59.3%	2.1%	NA	NA	NA	NA	3.4%	93.3%	24.4%	12/87
63.8%	4.2%	97.3	0.2	14.1%	NM	92.9%	54.8%	38.0%	7/87
64.9%	0.8%	128.8	4.0	7.7%	NM	67.0%	26.0%	0.5%	12/87
75.1%	0.0%	260.6	4.7	19.4%	NM	143.7%	45.7%	NA	5/87
44.6%	4.0%	98.7	7.0	5.1%	NM	47.6%	39.9%	64.1%	9/87
64.5%	6.6%	86.9	2.3	3.2%	13.8%	60.2%	19.3%	26.8%	3/87
49.9%	8.1%	129.1	8.5	6.4%	37.6%	75.4%	17.2%	42.8%	12/87
80.2%	0.7%	90.5	2.2	-14.8%	-23.3%	41.7%	10.7%	17.6%	12/87
57.8%	6.2%	113.5	-21.3	-9.3%	NM	-74.1%	37.4%	79.2%	7/87
68.1%	5.1%	82.4	3.0	8.8%	-11.2%	136.0%	11.5%	18.0%	12/87
49.6%	13.1%	122.8	5.7	35.5%	16.8%	53.5%	26.8%	14.4%	12/87
72.3%	2.2%	58.3	2.0	67.5%	70.9%	31.2%	84.7%	10.6%	2/87
73.4%	1.4%	80.4	1.8	4.3%	-13.3%	118.8%	41.9%	NA	9/87
30.7%	12.8%	141.8	16.0	4.2%	-0.1%	108.8%	16.6%	35.9%	12/87
64.8%	4.9%	84.2	3.5	NA	NA	37.8%	65.1%	32.0%	12/87
51.5%	0.6%	120.8	12.7	6.7%	6.9%	10.7%	2.5%	0.0%	5/87
55.6%	9.6%	96.6	-2.4	NA	NA	366.7%	2.7%	28.0%	12/87
56.1%	5.4%	151.7	9.6	249.5%	NM	35.0%	0.0%	19.6%	6/87
70.4%	3.6%	82.4	4.9	13.9%	1.7%	52.2%	16.8%	75.0%	12/87
72.7%	7.5%	120.9	11.4	54.3%	206.9%	52.0%	35.0%	69.7%	12/87
52.8%	6.1%	87.6	-3.0	27.6%	NM	489.1%	7.5%	NA	6/87
66.0%	3.1%	36.3	2.1	17.7%	38.8%	91.9%	43.9%	43.0%	12/87
60.8%	3.0%	75.0	5.6	7.9%	8.9%	37.3%	23.4%	19.0%	12/87
66.7%	8.6%	166.8	-7.4	7.8%	NM	-187.6%	20.3%	30.3%	12/87
53.5%	4.4%	90.7	3.8	18.7%	NM	96.6%	33.1%	49.1%	10/87
58.4%	6.9%	177.2	10.1	19.5%	10.8%	33.8%	16.4%	3.1%	12/87
60.7%	10.0%	72.1	-13.8	-3.5%	NM	-45.2%	22.1%	52.8%	12/87
11.6%	10.5%	213.9	34.5	60.8%	74.0%	11.2%	4.2%	30.3%	1/88
57.8%	1.3%	176.4	0.1	-4.2%	NM	4.5%	159.7%	10.8%	12/87
72.8%	1.3%	62.4	3.0	8.7%	14.1%	42.8%	27.9%	NA	12/87
76.7%	0.0%	169.5	2.7	13.4%	NM	49.1%	33.5%	NA	1/88
58.7%	6.4%	84.4	5.5	11.1%	10.7%	47.0%	18.2%	19.0%	12/87
48.7%	11.0%	113.0	4.6	120.8%	NM	339.5%	38.3%	14.6%	12/87
75.5%	2.0%	39.3	1.6	4.7%	3.8%	63.7%	24.3%	19.7%	12/87
66.9%	4.7%	77.2	0.1	4.4%	-50.6%	124.2%	45.6%	11.4%	12/87
61.6%	0.9%	58.8	-0.2	6.1%	NM	168.1%	71.2%	NA	12/87
46.8%	7.4%	124.4	11.7	14.2%	44.0%	41.4%	10.3%	47.0%	4/87
64.0%	0.0%	83.0	4.0	8.4%	5.2%	44.6%	37.3%	20.6%	12/87
75.0%	0.0%	155.3	1.4	11.8%	-15.3%	87.4%	23.0%	NA	6/87
77.5%	1.3%	152.8	9.6	3.4%	13.9%	153.5%	27.1%	NA	12/87
61.9%	6.7%	90.9	11.6	NA	NA	66.1%	51.6%	16.0%	3/87
75.3%	0.0%	253.6	2.2	17.5%	-4.4%	61.5%	65.0%	NA	3/87
64.9%	9.2%	30.5	2.0	18.0%	9.8%	98.6%	3.2%	46.5%	9/87
54.2%	2.2%	98.7	3.7	20.6%	22.1%	98.0%	35.4%	6.8%	9/87
53.0%	8.2%	74.7	-0.8	2.3%	NM	52.0%	37.0%	17.9%	12/87
63.1%	4.7%	97.0	1.7	9.4%	-23.3%	70.3%	13.8%	40.7%	9/87

Source: ELECTRONIC BUSINESS

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES

Ranking: 151-200

Rank 1987	Rank 1986	Company	Calendar year 1987			Fiscal year 1987			Return on equity	Return on investment
			Electronics revenue (\$ millions)	Total revenue (\$ millions)	Net income (\$ millions)	Total revenue (\$ millions)	Net income (\$ millions)			
151	135	Sundstrand	\$228.0	\$1,365.5	\$34.6	\$1,365.5	\$34.6	5.8%	3.7%	
152	152	Measorex	227.4	227.4	26.8	227.4	26.8	15.8%	15.2%	
153	130	BRIntec	222.2	293.7	5.9	293.7	5.9	10.0%	4.0%	
154	164	Mentor Graphics	221.8	221.8	20.3	221.8	20.3	10.8%	10.5%	
155	144	Avantek	213.7	213.7	11.6	213.7	11.6	7.5%	7.5%	
156	—	Cullinet Software	213.4	213.4	-30.6	174.9	-27.6	-23.2%	-20.3%	
157	154	Micom Systems	211.5	211.5	9.3	196.7	12.2	7.1%	6.8%	
158	145	Logicon	211.4	211.4	6.5	204.8	6.1	10.5%	10.5%	
159	166	Veeco Instruments	211.1	211.1	9.8	195.6	9.2	9.2%	6.2%	
160	—	Everex Systems	210.1	210.1	10.2	157.5	8.6	11.7%	11.2%	
161	143	Fluke	206.7	206.7	2.3	206.3	2.0	1.9%	1.7%	
162	178	Applied Materials	202.3	202.3	7.5	174.4	0.3	0.2%	0.2%	
163	172	Ultimate	201.1	201.1	17.4	172.9	13.8	15.5%	14.5%	
164	176	Digital Communications	200.6	200.6	34.2	181.4	27.0	17.2%	17.2%	
165	128	Cincinnati Milacron	200.0	828.0	-80.0	828.0	-80.0	-37.2%	-19.4%	
166	198	Anthem Electronics	196.9	196.9	5.0	196.9	5.0	7.3%	6.7%	
167	—	Imo Delaval	196.7	368.5	20.1	368.5	18.7	9.0%	4.0%	
168	155	Bell & Howell	195.0	726.9	21.0	726.9	21.0	7.7%	4.6%	
169	146	GenRad	193.8	193.8	2.1	193.8	2.1	2.9%	1.4%	
170	156	General DataComm	192.6	192.6	-8.3	200.6	0.8	0.9%	0.7%	
171	179	Esterline	192.0	270.4	-28.0	259.7	-29.3	-39.1%	-21.6%	
172	183	Dynascan	191.6	191.6	6.6	191.6	6.6	14.5%	9.1%	
173	150	Decision Industries ³	191.4	191.4	-23.3	191.4	-20.4	-28.0%	-27.8%	
174	199	Olin	190.0	1,930.0	78.0	1,930.0	78.0	11.1%	6.8%	
175	—	Combustion Engineering	189.8	3,042.1	56.6	3,042.1	56.6	6.6%	4.6%	
176	—	Oracle Systems	186.9	186.9	23.3	131.3	15.6	18.9%	16.1%	
177	167	Ametek	185.0	620.1	41.2	620.1	41.2	16.3%	9.9%	
178	—	Stratus Computer	184.2	184.2	19.4	184.2	19.4	18.9%	17.6%	
179	169	Sun Electric ⁴	181.6	181.6	2.6	203.9	3.3	4.1%	2.5%	
180	173	ISC Systems	179.4	179.4	8.1	168.5	6.5	6.5%	5.4%	
181	—	Quantum	178.3	178.3	8.1	120.8	8.8	8.1%	8.1%	
182	186	ADC Telecommunications	177.7	177.7	17.4	166.9	15.3	20.1%	19.3%	
183	189	Burndy	176.0	283.9	11.6	283.9	11.6	7.2%	5.3%	
184	200	Thomas & Betts	175.0	436.5	48.5	436.5	48.5	16.8%	14.6%	
185	—	Inmac	174.5	174.5	7.3	165.4	7.7	22.9%	20.0%	
186	—	Oak Industries	173.1	182.2	5.7	182.2	5.7	7.2%	4.8%	
187	160	Cipher Data Products	172.9	172.9	5.2	178.2	4.3	3.1%	3.1%	
188	—	VLSI Technology	172.0	172.0	8.1	172.0	8.1	5.7%	3.9%	
189	193	Coherent	171.5	171.5	0.7	159.0	-1.1	-1.3%	-1.0%	
190	—	3Com	171.1	171.1	15.0	110.4	11.1	14.6%	14.5%	
191	159	NAI	170.0	261.5	-17.9	278.3	5.9	6.5%	3.7%	
192	192	Altos Computer Systems	168.3	168.3	14.4	153.9	9.7	9.1%	7.4%	
193	187	Intelligent Systems	163.2	163.2	10.2	163.2	10.2	24.7%	16.4%	
194	—	Cherry Electrical Products	160.7	187.4	5.6	160.6	2.7	4.4%	2.8%	
195	—	Gencorp	158.6	1,619.0	18.0	1,619.0	18.0	-9.3%	5.8%	
196	171	Tyco Laboratories	156.0	1,252.1	51.3	1,062.9	44.1	18.7%	11.7%	
197	195	United Industrial	155.0	297.5	14.3	297.5	14.3	14.7%	9.8%	
198	—	Brush Wellman	153.8	307.6	26.2	307.6	26.2	10.8%	8.9%	
199	—	Insilco	153.2	639.7	33.9	639.7	33.9	11.3%	6.9%	
200	190	Pittway	152.0	649.1	32.4	649.1	32.4	10.4%	8.5%	

² went private April 29, 1988

⁴ calendar year 1987 includes only 11 months from Feb. to Dec. Changed fiscal year from Oct. to Dec.

NA = not available

NM = not meaningful

Cost of goods as a percentage of revenue	Fiscal year 1987			Five-year growth (Compounded average annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee (\$ thousands)	Net income per employee (\$ thousands)	Revenue	Net income				
60.4%	5.2%	\$96.2	\$2.4	7.3%	-13.0%	78.4%	36.5%	22.2%	12/87
52.9%	7.3%	89.5	10.6	14.0%	NM	22.1%	3.5%	59.4%	11/87
76.1%	1.5%	75.1	1.5	4.0%	NM	73.5%	60.3%	15.8%	12/87
43.0%	10.9%	184.9	\$16.9	164.1%	NM	43.2%	3.0%	45.9%	12/87
55.9%	12.3%	70.3	3.8	20.6%	4.3%	97.7%	0.0%	13.0%	12/87
87.8%	28.5%	72.6	-11.5	28.8%	NM	-124.9%	12.3%	26.4%	4/87
44.9%	11.3%	96.3	6.0	27.8%	8.8%	45.7%	4.2%	10.0%	3/87
83.1%	0.8%	81.9	2.4	18.9%	14.4%	52.0%	0.0%	NA	3/87
54.3%	6.2%	67.4	3.2	11.3%	1.6%	68.6%	32.2%	46.1%	9/87
74.9%	5.3%	150.0	8.2	NA	NA	39.6%	4.3%	14.8%	7/87
41.6%	10.8%	86.0	0.8	25.9%	-15.7%	66.9%	9.7%	40.5%	9/87
53.8%	17.9%	124.1	0.2	13.9%	NM	119.6%	14.4%	43.9%	10/87
49.7%	2.6%	384.1	30.6	42.1%	36.6%	37.8%	6.0%	23.4%	4/87
28.3%	11.6%	153.0	22.8	66.4%	107.7%	57.4%	0.0%	19.0%	6/87
74.9%	4.3%	89.5	-8.6	1.7%	NM	-23.3%	47.9%	19.8%	12/87
76.7%	0.0%	447.5	11.4	38.5%	27.3%	15.0%	7.5%	NA	12/87
64.4%	2.0%	56.7	2.9	NA	NA	34.8%	55.4%	29.0%	12/87
59.8%	5.0%	81.3	2.4	3.5%	2.6%	86.9%	39.7%	31.1%	12/87
39.2%	13.6%	91.7	1.0	0.6%	-25.1%	66.0%	50.4%	40.4%	12/87
50.6%	12.6%	76.0	0.3	27.0%	NM	134.9%	21.2%	21.9%	9/87
63.5%	4.7%	82.3	-9.3	6.0%	NM	-14.5%	44.6%	39.1%	10/87
73.4%	0.8%	496.3	17.1	18.2%	14.2%	22.1%	37.2%	2.1%	12/87
74.7%	5.7%	123.9	-13.2	20.9%	NM	-31.9%	0.4%	5.5%	11/87
69.3%	3.2%	136.9	5.5	4.2%	14.9%	72.3%	38.7%	12.6%	12/87
82.0%	1.7%	110.3	2.1	5.1%	-10.5%	74.3%	30.1%	33.1%	12/87
61.7%	6.0%	117.1	13.9	NA	NA	80.6%	14.7%	46.8%	5/87
71.0%	3.7%	88.6	5.9	7.9%	8.6%	72.7%	39.1%	NA	12/87
31.7%	10.3%	150.4	15.8	101.8%	NM	49.6%	7.3%	29.2%	12/87
53.2%	2.4%	83.5	1.3	5.5%	NM	55.5%	37.2%	30.0%	10/87
54.4%	8.4%	94.3	3.7	22.1%	-4.2%	68.4%	17.0%	NA	6/87
61.4%	9.5%	173.5	12.7	54.6%	116.3%	42.6%	0.0%	21.0%	3/87
47.8%	9.3%	92.9	8.5	21.8%	26.9%	47.5%	4.3%	12.4%	10/87
60.6%	4.4%	69.9	2.9	4.6%	-5.4%	61.5%	25.4%	44.3%	12/87
45.8%	4.3%	103.9	11.5	9.6%	15.4%	96.8%	13.3%	41.5%	12/87
62.8%	0.0%	258.5	12.1	NA	NA	28.9%	12.9%	59.2%	7/87
77.7%	2.2%	47.4	1.5	-9.6%	NM	47.7%	34.1%	14.4%	12/87
67.9%	11.3%	94.7	2.3	25.0%	12.5%	55.5%	1.8%	18.4%	6/87
42.5%	17.8%	127.9	6.0	51.9%	NM	152.1%	32.5%	22.1%	12/87
58.8%	11.3%	98.3	-0.7	14.6%	9.5%	222.4%	20.8%	46.4%	9/87
46.2%	8.4%	200.0	20.2	NA	NA	43.7%	0.4%	24.0%	5/87
50.1%	3.5%	88.5	1.9	22.7%	-11.6%	31.3%	43.5%	NA	6/87
55.9%	9.0%	196.8	12.4	24.7%	11.1%	199.8%	19.3%	42.0%	6/87
61.6%	4.0%	333.1	20.8	46.0%	26.0%	17.1%	33.6%	26.6%	12/87
66.4%	6.0%	55.7	0.9	12.3%	-8.5%	114.5%	36.8%	49.4%	2/87
77.2%	2.2%	114.8	1.3	NA	NA	200.0%	162.6%	NA	11/87
74.9%	0.5%	100.3	4.2	0.1%	13.7%	68.0%	37.3%	8.8%	5/87
74.7%	0.0%	63.8	3.1	8.5%	4.4%	63.6%	33.0%	NA	12/87
63.5%	2.1%	120.0	10.2	14.4%	8.1%	58.3%	17.9%	26.2%	12/87
64.2%	0.6%	86.5	4.6	0.1%	5.7%	95.1%	38.6%	NA	12/87
59.1%	2.5%	81.1	4.0	9.8%	3.2%	77.2%	18.7%	19.4%	12/87

Source: ELECTRONIC BUSINESS

(Continued)

THE ELECTRONIC BUSINESS 200

ALPHABETICAL INDEX

COMPANY	RANK	COMPANY	RANK	COMPANY	RANK
ADC Telecommunications Inc.	182	Eastman Kodak Co.	15	NCR Corp.	11
AM International Inc.	106	Eaton Corp.	64	Nashua Corp.	107
AMP Inc.	34	Eli Lilly & Co.	118	National Semiconductor Corp.	36
AST Research Inc.	122	Emerson Electric Co.	39	Northrop Corp.	49
AT&T Co.	2	Emerson Radio Corp.	63	Oak Industries Inc.	186
AVX Corp.	126	Emhart Corp.	96	Olin Corp.	174
Advanced Micro Devices Inc.	57	Esterline Corp.	171	Oracle Systems Corp.	176
Allied-Signal Inc.	18	Everex Systems Inc.	160	Paradyne Corp.	149
Altos Computer Systems	192	Figgie International Inc.	134	Penn Central Corp.	112
Amdahl Corp.	41	Fluke Mfg. Co. Inc., John	161	Perkin-Elmer Corp., The	46
Ametek Inc.	177	Ford Motor Co.	24	Pioneer-Standard Electronics Inc.	146
Analog Devices Inc.	97	Foxboro Co., The	131	Pitney Bowes Inc.	31
Andrew Corp.	150	GM Hughes Electronics Corp.	3	Pittway Corp.	200
Anthem Electronics Inc.	166	GTE Corp.	38	Polaroid Corp.	111
Apollo Computer Inc.	78	GenRad Inc.	169	Premier Industrial Corp.	120
Apple Computer Inc.	22	Gencorp Inc.	195	Prime Computer Inc.	58
Applied Magnetics Corp.	147	General DataComm Industries Inc.	170	Quantum Corp.	181
Applied Materials Inc.	162	General Dynamics Corp.	55	Raychem Corp.	87
Arrow Electronics Inc.	77	General Electric Co.	6	Raytheon Co.	14
Ashton-Tate Corp.	132	General Instrument Corp.	50	Recognition Equipment Inc.	129
Atari Corp.	82	General Signal Corp.	70	Reynolds & Reynolds Co.	148
Augat Inc.	114	Genicom Corp.	119	Rockwell International Corp.	16
Avantek Inc.	155	Gerber Scientific Inc.	141	SCI Systems Inc.	73
Avnet Inc.	42	Gould Inc.	60	Savin Corp.	133
Ball Corp.	144	Grumman Corp.	51	Scientific-Atlanta Inc.	81
Bally Manufacturing Corp.	140	Harris Corp.	30	Seagate Technology	53
Bell & Howell Co.	168	Hewlett-Packard Co.	8	Singer Co., The	40
Bell Industries Inc.	143	Honeywell Inc.	10	SmithKline Beckman Corp.	67
Boeing Co., The	33	IBM Corp.	1	Sprague Technologies Inc.	89
Bolt Beranek and Newman Inc.	125	ISC Systems Corp.	180	Square D Co.	127
BRIntec Corp.	153	ITT Corp.	27	Storage Technology Corp.	66
Brush Wellman Inc.	198	Imo Delaval Inc.	167	Stratus Computer Inc.	178
Burdry Corp.	183	Inmac Corp.	185	Sun Electric Corp.	179
CTS Corp.	138	Insilco Corp.	199	Sun Microsystems Inc.	65
Cherry Electrical Products Corp.	194	Intel Corp.	35	Sundstrand Corp.	151
Chrysler Corp.	59	Intelligent Systems Master L.P.	193	TIE/communications Inc.	128
Cincinnati Milacron Inc.	165	Intergraph Corp.	71	TRW Inc.	19
Cipher Data Products Inc.	187	Johnson Controls Inc.	62	Tandem Computers Inc.	52
Coherent Inc.	189	Kollmorgen Corp.	139	Tandon Corp.	123
Combustion Engineering Inc.	175	LPL Investment Group	105	Tandy Corp.	17
Compaq Computer Corp.	47	LSI Logic Corp.	137	Tektronix Inc.	44
CompuGraphic Corp.	100	LTV Corp.	93	Teledyne Inc.	48
Computer Associates International Inc.	74	Litton Industries Inc.	20	Teradyne Inc.	99
Computervision Corp.	75	Lockheed Corp.	13	Texas Instruments Inc.	12
Control Corp.	69	Logicon Inc.	158	Texttron Inc.	92
Control Data Corp.	26	Loral Corp.	61	Thomas & Betts Corp.	184
Convergent Inc.	98	Lotus Development Corp.	94	3Com Corp.	190
Cooper Industries Inc.	142	M/A-COM Inc.	88	Tyco Laboratories Inc.	196
Corning Glass Works	80	MAI Basic Four Inc.	109	Tyler Corp.	84
Cray Research Inc.	68	Mark IV Industries Inc.	116	Ultimate Corp., The	163
Cubic Corp.	117	Marshall Industries	108	Unisys Corp.	5
Cullinet Software Inc.	156	Martin Marietta Corp.	23	United Industrial Corp.	197
DSC Communications Corp.	115	Maxtor Corp.	145	United Technologies Corp.	43
Data General Corp.	45	McDonnell Douglas Corp.	37	United Telecommunications Inc.	83
Datapoint Corp.	113	Measurix Corp.	152	VLSI Technology Inc.	188
Dataproducts Corp.	110	Medtronic Inc.	79	Varian Associates Inc.	56
Decision Industries Inc.	173	Mentor Graphics Corp.	154	Veeco Instruments Inc.	159
Diasonics Inc.	130	Micom Systems Inc.	157	Wang Laboratories Inc.	21
Diebold Inc.	103	Micropolis Corp.	124	Watkins-Johnson Co.	136
Digital Communications Associates Inc.	164	Microsoft Corp.	86	Western Digital Corp.	76
Digital Equipment Corp.	4	MiniScribe Corp.	101	Westinghouse Electric Corp.	28
Dover Corp.	102	Minnesota Mining & Manufacturing Co.	25	Westmark International Inc.	121
DuPont, E.I. de Nemours & Co.	32	Molex Inc.	90	Wyle Laboratories Inc.	135
Dynascan Corp.	172	Monsanto Co.	72	Wyse Technology	95
Dynatech Corp.	104	Motorola Inc.	9	Xerox Corp.	7
E-Systems Inc.	54	NBI Inc.	191	Xidex Corp.	85
EG&G Inc.	91			Zenith Electronics Corp.	29

THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1987 figures	Revenue per employee (\$ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
Company								
COMMUNICATIONS								
Dynascan	\$496.3	3.4%	9.1%	73.4%	0.8%	0.9%	2.1%	172
3Com	200.0	10.1%	14.5%	46.2%	8.4%	5.7%	24.0%	190
TIE/communications	166.8	-4.4%	-5.1%	66.7%	8.6%	1.7%	30.3%	128
Digital Communications	153.0	14.9%	17.2%	28.3%	11.1%	10.5%	19.0%	164
Scientific-Atlanta	147.9	4.9%	11.6%	69.0%	4.1%	1.4%	15.0%	81
DSC Communications	122.8	4.7%	5.1%	49.6%	13.1%	7.4%	14.4%	115
Dynatech	98.3	7.6%	13.9%	40.8%	9.0%	4.1%	25.4%	104
Andrew	97.0	1.7%	2.2%	63.1%	4.7%	5.2%	40.7%	150
Micom Systems	96.3	6.2%	6.8%	44.9%	11.3%	4.6%	10.0%	157
ADC Telecommunications	92.9	9.1%	19.3%	47.8%	9.3%	6.7%	12.4%	182
Bolt Beranek and Newman	87.6	-3.4%	-8.7%	52.8%	6.1%	9.5%	0.0%	125
General DataComm Industries	76.0	0.4%	0.7%	50.6%	12.6%	7.6%	21.9%	170
Paradyne	74.7	-1.1%	-1.1%	53.0%	8.2%	5.2%	17.9%	149
Avantek	70.3	5.4%	7.5%	55.9%	12.3%	11.4%	13.0%	155
Motorola	68.6	4.6%	8.3%	53.2%	7.8%	9.8%	43.8%	9
M/A-COM	64.6	-6.7%	-7.5%	69.0%	5.6%	6.1%	21.5%	88
General Instrument	48.3	2.3%	2.8%	76.5%	3.1%	8.0%	16.2%	50
Weighted average	\$74.7	3.8%	6.1%	55.8%	7.5%	8.3%	33.3%	

GOVERNMENT								
GM Hughes Electronics	\$104.8	5.0%	6.7%	72.3%	4.0%	4.5%	11.6%	3
Gould	92.2	2.7%	3.0%	49.4%	10.1%	5.2%	38.0%	60
Harris	85.6	4.1%	7.4%	58.8%	5.7%	4.0%	14.7%	30
Honeywell	84.7	3.8%	7.0%	66.8%	4.3%	4.6%	20.6%	10
Watkins-Johnson	84.4	6.5%	12.0%	58.7%	6.4%	4.7%	19.0%	136
SCI Systems	83.0	2.9%	5.0%	93.0%	0.0%	5.4%	24.8%	73
Varian Associates	82.6	2.2%	4.1%	65.0%	8.2%	4.7%	23.6%	56
Logicon	81.9	3.0%	10.5%	83.1%	0.8%	1.9%	0.0%	158
Litton Industries	81.5	3.1%	10.8%	76.1%	4.7%	5.5%	22.7%	20
Cubic	80.4	2.2%	4.1%	73.4%	1.4%	4.7%	0.0%	117
E-Systems	79.1	4.9%	11.8%	81.4%	2.7%	4.2%	6.6%	54
Texas Instruments	71.7	4.6%	9.2%	71.5%	7.7%	8.3%	31.5%	12
Motorola	68.6	4.6%	8.3%	53.2%	7.8%	9.8%	43.8%	9
Singer	68.0	1.2%	1.5%	92.2%	2.0%	4.1%	0.0%	40
Loral	47.6	8.3%	13.6%	73.9%	4.6%	5.0%	6.2%	61
Weighted average	\$75.8	3.9%	7.4%	67.7%	5.7%	6.4%	25.4%	

DISTRIBUTORS								
Anthem Electronics	\$447.5	2.5%	6.7%	76.7%	0.0%	0.5%	0.0%	166
Arrow Electronics	308.0	-2.8%	-10.0%	79.4%	0.0%	0.4%	0.0%	77
Marshall Industries	260.6	1.8%	5.1%	75.1%	0.0%	3.2%	0.0%	108
Pioneer-Standard Electronics	253.6	0.9%	2.2%	75.3%	0.0%	1.1%	0.0%	146
Wyle Laboratories	169.5	1.6%	4.3%	76.7%	0.0%	1.0%	0.0%	135
Avnet	162.8	1.5%	2.6%	73.5%	0.0%	3.1%	0.0%	42
Weighted average	\$199.9	0.8%	1.7%	75.4%	0.0%	2.1%	0.0%	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1987 figures	Revenue per employee (\$ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
Company								

CAPITAL EQUIPMENT

Gerber Scientific	\$124.4	9.4%	11.7%	46.8%	7.4%	4.7%	47.0%	141
Applied Materials	124.1	0.2%	0.2%	53.8%	17.9%	6.6%	43.9%	162
Hewlett-Packard	98.7	8.0%	10.6%	42.6%	11.1%	6.3%	49.0%	8
Perkin-Elmer	94.5	-1.4%	-2.0%	52.6%	10.5%	5.0%	46.2%	46
GenRad	91.7	1.1%	1.4%	39.2%	13.6%	6.0%	40.4%	169
John Fluke	86.0	1.0%	1.7%	41.6%	10.8%	4.0%	40.5%	161
Sun Electric	83.5	1.6%	2.5%	53.2%	2.4%	2.3%	30.0%	179
Varian Associates	82.6	2.2%	4.1%	65.0%	8.2%	4.7%	23.6%	56
Esterline	82.3	-11.3%	-21.6%	63.5%	4.7%	1.0%	39.1%	171
Tektronix	81.6	3.7%	5.7%	39.8%	14.3%	4.8%	42.2%	44
Teradyne	80.4	-5.7%	-6.5%	50.2%	16.3%	10.8%	36.4%	99
Weighted average	\$93.9	5.0%	7.0%	45.8%	11.1%	5.8%	45.0%	

OFFICE EQUIPMENT

Savin	\$176.4	0.0%	0.1%	57.8%	1.3%	0.3%	10.8%	133
IBM	139.3	9.7%	12.0%	38.9%	10.0%	7.9%	54.0%	1
Datapoint	113.5	-18.7%	-20.1%	57.8%	6.2%	8.2%	79.2%	113
Xerox	104.2	5.6%	7.5%	45.1%	7.0%	9.1%	44.9%	7
Wang Laboratories	93.6	2.5%	3.1%	27.1%	7.5%	4.5%	40.1%	21
NCR	91.0	7.4%	17.7%	48.8%	6.3%	6.9%	54.6%	11
Diebold	90.0	6.1%	10.3%	64.6%	3.3%	1.9%	7.0%	103
Harris	85.6	4.1%	7.4%	58.8%	5.7%	4.0%	14.7%	30
Pitney Bowes	76.4	8.9%	13.5%	31.7%	2.9%	11.2%	19.5%	31
Weighted average	\$121.8	8.4%	11.1%	40.6%	8.9%	7.8%	50.0%	

COMPUTER-BASED SYSTEMS

Gerber Scientific	\$124.4	9.4%	11.7%	46.8%	7.4%	4.7%	47.0%	141
Intergraph	101.8	10.9%	12.2%	45.1%	10.5%	6.8%	36.9%	71
Hewlett-Packard	98.7	8.0%	10.6%	42.6%	11.1%	6.3%	49.0%	8
Coherent	98.3	-0.7%	-1.0%	58.8%	11.3%	5.3%	46.4%	189
ISC Systems	94.3	3.9%	5.4%	54.4%	8.4%	5.2%	0.0%	180
Recognition Equipment	90.7	4.2%	5.6%	53.5%	4.4%	8.2%	49.1%	129
Measurex	89.5	11.8%	15.2%	52.9%	7.3%	3.0%	59.4%	152
Honeywell	84.7	3.8%	7.0%	66.8%	4.3%	4.6%	20.6%	10
Sun Electric	83.5	1.6%	2.5%	53.2%	2.4%	2.3%	30.0%	179
Weighted average	\$92.4	6.2%	9.2%	53.1%	8.0%	5.5%	36.5%	

MEDICAL

Diasonics	\$177.2	5.7%	12.1%	58.4%	6.9%	3.0%	3.1%	130
Medtronic	101.4	14.7%	17.4%	28.4%	8.4%	5.7%	41.5%	79
Westmark International	96.6	-2.5%	-3.1%	55.6%	9.6%	3.6%	28.0%	121
Weighted average	\$111.9	7.7%	10.4%	43.5%	8.3%	4.4%	28.1%	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1987 figures	Revenue per employee (\$ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
Company								
SEMICONDUCTORS								
Western Digital	\$138.5	9.3%	20.3%	59.3%	8.1%	8.8%	36.9%	76
VLSI Technology	127.9	4.7%	3.9%	42.5%	17.8%	29.1%	22.1%	188
LSI Logic	113.0	4.1%	2.2%	48.7%	11.0%	66.6%	14.6%	137
Intel	99.3	9.2%	8.5%	45.7%	13.6%	15.8%	38.8%	35
Gould	92.2	2.7%	3.0%	49.4%	10.1%	5.2%	38.0%	60
Harris	85.6	4.1%	7.4%	58.8%	5.7%	4.0%	14.7%	30
Texas Instruments	71.7	4.6%	9.2%	71.5%	7.7%	8.3%	31.5%	12
Analog Devices	71.2	5.0%	5.6%	37.3%	15.1%	11.6%	46.4%	97
Motorola	68.6	4.6%	8.3%	53.2%	7.8%	9.8%	43.8%	9
National Semiconductor	64.0	-1.5%	-2.9%	62.1%	11.7%	5.1%	42.1%	36
Advanced Micro Devices	55.3	-4.8%	-6.0%	41.1%	24.9%	13.8%	27.2%	57
Weighted average	\$74.0	4.0%	6.3%	57.6%	9.6%	9.8%	35.5%	
COMPONENTS (other than semiconductors)								
AMP	\$105.4	10.8%	16.3%	56.8%	8.8%	7.4%	52.3%	34
Augat	82.4	3.7%	4.8%	68.1%	5.1%	9.4%	18.0%	114
Molex	77.9	11.2%	13.3%	46.2%	5.5%	12.8%	68.4%	90
BRIntec	75.1	2.0%	4.0%	76.1%	1.5%	3.2%	15.8%	153
Cherry Electrical Products	55.7	1.7%	2.8%	66.4%	6.0%	9.6%	49.4%	194
Sprague Technologies	50.8	0.8%	1.0%	74.1%	4.8%	5.6%	38.2%	89
Oak Industries	47.4	3.1%	4.8%	77.7%	2.2%	3.4%	14.4%	186
CTS	39.3	4.0%	6.3%	75.5%	2.0%	5.1%	19.7%	138
AVX	33.3	5.8%	4.8%	66.0%	3.1%	11.7%	43.0%	126
Weighted average	\$72.1	7.5%	10.5%	62.3%	6.4%	7.6%	43.7%	
PERIPHERALS								
Intelligent Systems	\$333.1	6.2%	16.4%	61.6%	4.0%	1.7%	26.6%	193
Quantum	173.5	7.3%	8.1%	61.4%	9.5%	4.9%	21.0%	181
AST Research	151.7	6.3%	13.1%	56.1%	5.4%	3.0%	19.6%	122
Wyse Technology	128.7	7.0%	18.2%	66.4%	5.3%	3.1%	20.2%	95
Decision Industries	123.9	-10.7%	-27.8%	74.7%	5.7%	2.6%	5.5%	173
Micropolis	120.9	9.4%	12.7%	72.7%	7.5%	7.7%	69.7%	124
Control Data	97.6	0.7%	1.7%	63.3%	11.6%	5.3%	20.0%	26
Cipher Data Products	94.7	2.4%	3.1%	67.9%	11.3%	3.3%	18.4%	187
Maxtor	90.9	12.8%	10.7%	61.9%	6.7%	9.9%	16.0%	145
Dataproducts	86.9	2.6%	3.3%	64.5%	6.6%	3.2%	26.8%	110
Storage Technology	84.6	2.5%	3.1%	59.5%	8.0%	23.9%	0.0%	66
Genicom	84.2	4.2%	7.5%	64.8%	4.9%	3.1%	32.0%	119
Xidex	83.0	-7.8%	-8.4%	76.7%	2.0%	0.4%	29.9%	85
Tandon	82.4	5.9%	15.2%	70.4%	3.6%	4.2%	75.0%	123
MiniScribe	72.9	7.8%	14.0%	71.3%	5.5%	13.9%	36.1%	101
Seagate Technology	59.9	14.6%	21.3%	68.6%	3.5%	8.2%	43.6%	53
Applied Magnetics	30.5	6.7%	9.2%	64.9%	9.2%	12.1%	46.5%	147
Weighted average	\$86.1	3.5%	5.8%	65.6%	7.9%	7.1%	26.7%	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1987 figures	Revenue per employee (\$ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
Company								
MAINFRAMES								
Amdahl	\$198.0	9.4%	15.4%	47.8%	11.9%	10.5%	44.3%	41
Cray Research	159.5	21.4%	20.2%	11.4%	15.8%	5.8%	37.0%	68
IBM	139.3	9.7%	12.0%	38.9%	10.0%	7.9%	54.0%	1
Unisys	105.0	6.0%	8.7%	32.5%	6.1%	7.4%	43.6%	5
Control Data	97.6	0.7%	1.7%	63.3%	11.6%	5.3%	20.0%	26
NCR	91.0	7.4%	17.7%	48.8%	6.3%	6.9%	54.6%	11
Weighted average	\$127.3	8.7%	11.8%	39.8%	9.4%	7.7%	50.8%	
MINICOMPUTERS								
Stratus Computer	\$150.4	10.5%	17.6%	31.7%	10.3%	7.5%	29.2%	178
Tandem Computers	147.8	10.2%	14.4%	29.6%	10.5%	13.7%	44.4%	52
IBM	139.3	9.7%	12.0%	38.9%	10.0%	7.9%	54.0%	1
Apollo Computer	138.4	3.9%	6.3%	44.5%	11.0%	9.7%	51.8%	78
Sun Microsystems	128.5	6.8%	9.0%	46.1%	12.9%	14.2%	32.0%	65
Prime Computer	109.0	6.7%	6.1%	38.2%	11.4%	10.5%	48.0%	58
MAI Basic Four	98.7	7.1%	17.6%	44.6%	4.0%	4.1%	64.1%	109
Hewlett-Packard	98.7	8.0%	10.6%	42.6%	11.1%	6.3%	49.0%	8
Gould	92.2	2.7%	3.0%	49.4%	10.1%	5.2%	38.0%	60
Digital Equipment	85.0	12.1%	17.3%	22.3%	10.8%	8.0%	47.0%	4
Data General	81.2	-6.5%	-11.7%	47.8%	12.5%	11.2%	45.0%	45
Weighted average	\$121.8	9.4%	11.9%	37.5%	10.3%	7.9%	51.9%	
MICROCOMPUTERS								
Apple Computer	\$475.2	8.2%	26.0%	46.1%	7.2%	3.2%	27.1%	22
Compaq Computer	306.0	11.1%	24.8%	56.8%	3.8%	9.3%	26.0%	47
Altos Computer Systems	196.8	6.3%	7.4%	55.9%	9.0%	18.8%	42.0%	192
AST Research	151.7	6.3%	13.1%	56.1%	5.4%	3.0%	19.6%	122
IBM	139.3	9.7%	12.0%	38.9%	10.0%	7.9%	54.0%	1
Atari	120.6	9.0%	14.2%	60.8%	3.7%	0.8%	45.9%	82
Tandy	88.5	7.0%	15.3%	47.4%	0.0%	2.7%	1.6%	17
Tandon	82.4	5.9%	15.2%	70.4%	3.6%	4.2%	75.0%	123
Zenith Electronics	67.5	-0.8%	-2.1%	83.7%	4.4%	2.3%	17.2%	29
Weighted average	\$134.8	9.1%	12.3%	42.0%	9.0%	7.2%	48.2%	
SOFTWARE								
Ultimate	\$384.1	8.0%	14.5%	49.7%	2.6%	4.6%	23.4%	163
Ashton-Tate	213.9	16.1%	23.0%	11.6%	10.5%	2.4%	30.3%	132
Microsoft	190.5	20.8%	29.2%	19.2%	11.0%	16.8%	42.3%	86
Lotus Development	188.4	18.2%	30.0%	13.4%	14.8%	6.7%	52.3%	94
Mentor Graphics	184.9	9.2%	10.5%	43.0%	10.9%	6.6%	45.9%	154
Oracle Systems	117.1	11.9%	16.1%	61.7%	6.0%	12.9%	46.8%	176
Computer Associates International	114.6	11.8%	11.1%	-8.8%	13.0%	3.4%	48.7%	74
Cullinet Software	72.6	-15.8%	-20.3%	87.8%	28.5%	6.3%	26.4%	156
Weighted average	\$154.8	12.2%	16.1%	26.7%	12.4%	7.5%	41.3%	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

THE ELECTRONIC BUSINESS 200

BEST AND WORST PERFORMERS

NET INCOME/REVENUE

(percentage)

TOP 10

	200 rank
Cray Research	68
Microsoft	86
Lotus Development	94
Ashton-Tate	132
Digital Communications	164
Medtronic	79
Seagate Technology	53
SmithKline Beckman	67
Maxtor	145
Digital Equipment	4

MEDIAN 4.7%

BOTTOM 5

Decision Industries	173
Esterline	171
Cullinet Software	156
Datapoint	113
Foxboro	131

R&D/REVENUE

(percentage)

TOP 10

	200 rank
Cullinet Software	156
Advanced Micro Devices	57
Applied Materials	162
VLSI Technology	188
Teradyne	99
Cray Research	68
Analog Devices	97
Lotus Development	94
Tektronix	44
Intel	35

MEDIAN 5.4%

For those 183 companies that reported research & development expenditures

RETURN ON EQUITY

(percentage)

TOP 10

	200 rank
Seagate Technology	53
SmithKline Beckman	67
Lotus Development	94
Compaq Computer	47
Microsoft	86
MAI Basic Four	109
MiniScribe	101
Emerson Radio	63
General Dynamics	55
Atari	82

MEDIAN 11.2%

BOTTOM 5

Decision Industries	173
Datapoint	113
Cincinnati Milacron	165
Esterline	171
Foxboro	131

RETURN ON INVESTMENT

(percentage)

TOP 10

	200 rank
Lotus Development	94
Microsoft	86
Apple Computer	22
Compaq Computer	47
Ashton-Tate	132
General Dynamics	55
Seagate Technology	53
Ford Motor	24
SmithKline Beckman	67
Western Digital	76

MEDIAN 7.5%

BOTTOM 5

Cullinet Software	156
Esterline	171
LTV	93
Decision Industries	173
Foxboro	131

THE ELECTRONIC BUSINESS 200

BEST AND WORST PERFORMERS

REVENUE PER EMPLOYEE

(\$ thousands)

		200 rank
TOP 10		
Emerson Radio	\$1,012.6	63
Dynascan	496.3	172
Apple Computer	475.2	22
Anthem Electronics	447.5	166
Ultimate	384.1	163
Intelligent Systems	333.1	193
Arrow Electronics	308.0	77
Compaq Computer	306.0	47
Marshall Industries	260.6	108
Inmac	258.5	185
MEDIAN	\$97.0	
BOTTOM 5		
Loral	\$47.6	61
Oak Industries	47.4	186
CTS	39.3	138
AVX	36.3	126
Applied Magnetics	30.5	147

NET INCOME PER EMPLOYEE

(\$ thousands)

		200 rank
TOP 10		
Microsoft	\$39.6	86
Apple Computer	38.8	22
Ashton-Tate	34.5	132
Lotus Development	34.3	94
Cray Research	34.1	68
Compaq Computer	34.1	47
Emerson Radio	33.3	63
Ultimate	30.6	163
Digital Communications	22.8	164
Intelligent Systems	20.8	193
MEDIAN	\$4.3	
BOTTOM 5		
Esterline	-\$9.3	171
Cullinet Software	-11.5	156
Decision Industries	-13.2	173
Foxboro	-13.8	131
Datapoint	-21.3	113

FIVE-YEAR REVENUE GROWTH

(compounded average annual growth rate)

		200 rank
TOP 10		
Sun Microsystems	474.4%	65
Lotus Development	356.3%	94
AST Research	249.5%	122
Mentor Graphics	164.1%	154
MiniScribe	135.5%	101
LSI Logic	120.8%	137
Wyse Technology	102.7%	95
Stratus Computer	101.8%	178
Apollo Computer	98.2%	78
Seagate Technology	88.3%	53
MEDIAN	11.6%	
BOTTOM 5		
Storage Technology	-7.0%	66
Datapoint	-9.3%	113
Oak Industries	-9.6%	186
ITT	-11.7%	27
Penn Central	-14.8%	112

FIVE-YEAR NET INCOME GROWTH

(compounded average annual growth rate)

		200 rank
TOP 10		
Micropolis	206.9%	124
Emerson Radio	145.2%	63
Apollo Computer	135.4%	78
Quantum	116.3%	181
Digital Communications	107.7%	164
Amdahl	96.1%	41
Microsoft	83.0%	86
Seagate Technology	82.5%	53
Northrop	79.9%	49
Ashton-Tate	74.0%	132
MEDIAN	8.9%	
BOTTOM 5		
Penn Central	-23.3%	112
GenKad	-25.1%	169
General Instrument	-28.1%	50
Control Data	-30.6%	26
Kollmorgen	-50.6%	139

THE ELECTRONIC BUSINESS 200

BEST AND WORST PERFORMERS

FOREIGN REVENUE/TOTAL REVENUE

(percentage of total revenue)

TOP 10		200 rank
Datapoint	79.2%	113
Tandon	75.0%	123
Micropolis	69.7%	124
Molex	68.4%	90
MAI Basic Four	64.1%	109
Raychem	61.6%	87
Measurex	59.4%	152
Inmac	59.2%	185
NCR	54.6%	11
IBM	54.0%	1

MEDIAN 28.0%

BOTTOM 5

Loral	6.2%	61
Decision Industries	5.5%	173
Diasonics	3.1%	130
Dynascan	2.1%	172
Tandy	1.6%	17

CAPITAL EXPENDITURES

(percentage of net cash flow after dividends)

TOP 10		200 rank
Data General	576.1%	45
Perkin-Elmer	492.2%	46
Bolt Beranek and Newman	489.1%	125
Teradyne	374.1%	99
Westmark International	366.7%	121
LSI Logic	339.5%	137
Zenith Electronics	247.3%	29
Coherent	222.4%	189
United Telecommunications	218.9%	83
Gencorp	200.0%	195

MEDIAN 65.2%

BOTTOM 5

Cullinet Software	-124.9%	156
Xidex	-150.0%	85
TIE/communications	-187.6%	128
M/A-COM	-295.1%	88
Convergent	-600.3%	98

THE 200: ARRIVALS AND DEPARTURES

ARRIVALS	1987 rank	DEPARTURES	1986 rank	
Computer Associates	74	ADT ¹	163	¹ acquired by Hawley Group Ltd. Oct. 5, 1987
Raychem	87	Allen Group	165	
Sprague Technologies	89	Analogic	170	² acquired by Seedham Inc. Sept. 4, 1987
LPL Investment Group	105	Aydin	196	³ sold its electronics distribution businesses to Arrow Electronics Inc. Jan. 12, 1988
MAI Basic Four	109	Becton, Dickinson	181	⁴ acquired by Chrysler Corp. Aug. 21, 1987
Westmark International	121	Data Card ²	175	⁵ acquired by Hanson Trust Plc Jan. 5, 1988
Cullinet Software	156	Ducommun ³	87	⁶ acquired by Advanced Micro Devices Aug. 12, 1987
Everex Systems	160	Electrospace Systems ⁴	161	⁷ owned by N.V. Philips
Imo Delaval	167	Fairchild Industries	197	⁸ acquired by Ciba-Geigy Ltd.
Combustion Engineering	175	International Rectifier	177	⁹ changed name to Sequa Corp.
Oracle Systems	176	Kidde ⁵	162	¹⁰ acquired by Memorex International N.V. Jan. 28, 1988
Stratus Computer	178	Mark Controls	185	¹¹ acquired by Westmark Systems Inc. (privately held) Dec. 22, 1987
Quantum	181	Monolithic Memories ⁶	140	¹² acquired by Computer Associates International Inc. Aug. 20, 1987
Inmac	185	North American Philips ⁷	18	
Oak Industries	186	Spectra-Physics ⁸	142	
VLSI Technology	188	Sun Chemical ⁹	191	
3Com	190	Telex ¹⁰	62	
Cherry Electrical	194	Tracor ¹¹	76	
Gencorp	195	UCCEL ¹²	188	
Brush Wellman	198	Union Carbide	122	
Insilco	199	Unitrode	182	

Stop harping about Japan's electronics prowess

In terms of productivity, sales and net income growth, the top U.S. electronics firms outperformed their Japanese rivals last year

BY PAULA DOE

After two hard years, Japan's major electronics producers are starting to see results from their efforts to cope with the high-valued yen. Sales of the top 20 electronics companies in Japan revived to a healthy 9.9% growth rate for the fiscal year ended March 1988. And net income for the same group of companies surged 35.4% during the same time period.

Nonetheless, U.S. companies did better across the board (see accompanying table). Although sales of the leading U.S. electronics producers only slightly outpaced those of their Japanese counterparts, net income grew significantly faster. The top 20 U.S. electronics companies' net income surged 48.1% last year. The U.S. companies' aggregate net income was 7.5% of sales, roughly three times the Japanese percentage.

ELECTRONIC BUSINESS tracks the consolidated financial results for the 20 largest electronics companies in Japan. The Japanese figures (see accompanying table) are then compared against those from the top 20 U.S. electronics companies from our ELECTRONIC BUSINESS 200 listing, published in our July 15th issue.

In spite of Japan's intense efforts to improve productivity during the past couple of years, the U.S. sector made greater gains. While Japanese sales per employee were up 10.1%, the top 20 U.S. companies saw 12.4% improvement. And in terms of net income per employee, the Japanese growth of 38.1% was outpaced by the U.S. increase of 48.4%. In fact, U.S. productivity growth has been significantly higher for each of the past three years since ELECTRONIC BUSINESS began compiling these figures.

Revenue and earnings per employee are crude ways to compare productivity, since they reflect mar-

ket forces as well as output. However, better measures are hard to come by and, whatever the actual levels, the rate of change in revenue and earnings per employee still suggest a general trend in productivity growth.

While the United States is increasing its productivity faster than Japan, the Japanese appear to still be more productive. The average Japanese revenue per employee of \$211,400 was twice that of the United States. Still, the revenue-per-employee fig-

ures for Japan are artificially inflated by the web of affiliated firms that surrounds the major Japanese electronics corporations. Although the parent corporation's relationship with its affiliated supplier or distributor may be close, the parent typically does not own a high percentage of the affiliate, so the affiliate's workers are not counted in the parent's consolidated total of employees.

Furthermore, the Japan revenue-per-employee figures also looked huge last year because of the appreciation of the yen against the dollar.



Rod Thomas

In actuality, the figures for the top Japanese companies remain at only about 55% of their peak levels of 1984. U.S. revenue per employee, on the other hand, is up 16% from 1984.

Revenue figures aside, the U.S. top 20 far outpace their Japanese rivals in terms of income productivity. The average net income per employee figure for Japan was only \$5,000, much less than the U.S. average of \$7,900.

Kudos for the Japanese

Still, the Japanese deserve kudos for riding out the wild fluctuations in their currency. Japanese sales growth last year almost caught back up with U.S. levels. The 9.9% growth in yen-based electronics revenue at the big Japanese producers approached the 12.5% increase at the top 20 U.S. producers. In sharp contrast, Japanese sales two years ago were flat as the high yen devastated export sales. U.S. companies maintained 4% to 5% growth that year. The 9.9% growth in electronics sales outpaced the 7.1% increase in total sales at the Japanese companies, as

producers began to successfully move to higher value-added products — fewer toasters and fans, more computers and VCR camcorders.

Mitsubishi Electric Corp. led the Japanese recovery last year with a dramatic 55% increase in electronics revenue. Oki Electric Industry Company Ltd. also made a significant comeback with a 19% sales growth, after a rough year in 1986. Fujitsu Ltd. saw an impressive 14% increase in revenue, while NEC Corp. and Omron Tateisi Electronics Co. both saw 11% growth in overall sales. On the other hand, Hitachi Ltd. experienced a 6% decline in electronics revenue, but the company's total sales increased 3%. Sanyo Electric Company Ltd. saw its sales dip 14%.

With growth reviving and the yen strengthening against the dollar, the leading Japanese electronics producers look bigger and bigger. The top seven companies in Japan now have electronics sales exceeding \$10 billion each. To make last year's top 20 list, a company had to have electronics sales of at least \$2 billion. In 'act,

total sales of the Japanese top 20 are now 15% more than those of the 20 largest U.S. producers, and come to some 58% of those of the total ELECTRONIC BUSINESS 200.

In addition to revenue, earnings for the Japanese also started to recover after plummeting in each of the past two years. Thanks to intensive cost cutting efforts, companies reported big percentage increases in earnings last year, although margins still remain extremely thin. Net income was up 35.4%, but remained a meager 2.6% of sales, reflecting no change from the 2% to 3% of the last several years.

A 579% growth

Of the Japanese top 20, Omron had the most impressive earnings gain. The company's net income last year swelled 579% to \$166 million. Oki experienced a 144% surge in net income to \$40 million. Mitsubishi saw a 110% gain. Sanyo, however, reported a net income loss of \$140 million. The Osaka-based corporation, heavily dependent on exports, was

Japanese versus U.S. electronics companies in 1987*

	Japanese top 20	U.S. top 20
Electronics revenue		
(\$ billions)	\$173.1	\$151.5
Change from 1986	+9.9%	+12.5%
Total revenue		
(\$ billions)	\$275.3	\$154.2
Change from 1986	+7.1%	+12.2%
Net income		
(\$ billions)	\$6.8	\$11.5
Change from 1986	+35.4%	+48.1%
Net income/sales	2.6%	7.5%
Revenue per employee	\$211,400	\$105,734
Change from 1986	+10.1%	+12.4%
Net income per employee	\$5,000	\$7,898
Change from 1986	+38.1%	+48.4%

Conversion rate: ¥ 125 = \$1

* For Japanese companies, fiscal year ended March 1988

Source: ELECTRONIC BUSINESS



ASIA BUSINESS

FINANCE

the only major Japanese electronics company to lose money last year.

Only a very few of the most successful companies managed to earn more than 10 cents on the dollar from operations and more than 4 cents in net income. Nippon Telegraph and Telephone Corp., with its lucrative domination of the telecommunications market in Japan, had

operating income of 15% of revenue and net income of 4%. Kyocera Corp., with its domination of the worldwide ceramic package market, had operating income of 14% of sales, and net of 7.5%. Kyocera recently forecast a 23.4% increase in pretax recurring profits for the current fiscal year. TDK Electronics Company Ltd. also maintained its relatively healthy

bottom line with operating income of 12% and net of 4.5%.

Everybody else had operating income amounting to 5% of sales or less, and net income of 3% or less. Reliable consolidated figures for other measures of return, such as return on equity or return on investment, were not yet available for most of the Japanese companies. □

Japan's top electronics companies in 1987

	Electronics revenue (\$ millions)	Total revenue (\$ millions)	Net income (\$ millions)	Net income as a percentage of revenue	Revenue per employee	Net income per employee	Fiscal year ended
1 Matsushita ¹	\$28,500	\$38,552	\$1,303	3.4%	\$285,600	\$9,600	3/88
Change from 1986	11%	5%	-0.5%	—	—	—	
2 NEC	21,700	21,718	203	0.9%	212,000	2,000	3/88
Change from 1986	11%	11%	69%	—	—	—	
3 Toshiba	17,100	28,579	486	1.7%	234,000	4,000	3/88
Change from 1986	13%	8%	78%	—	—	—	
4 Hitachi	16,600	39,081	1,094	2.7%	248,900	6,800	3/88
Change from 1986	-6%	3%	39%	—	—	—	
5 Fujitsu ²	16,400	16,374	337	2.1%	172,700	3,600	3/88
Change from 1986	14%	14%	95%	—	—	—	
6 Sony ¹	11,700	11,655	294	2.5%	192,600	4,900	3/88
Change from 1986	10%	10%	-12%	—	—	—	
7 Mitsubishi ¹	11,400	18,946	178	0.9%	256,000	2,400	3/88
Change from 1986	55%	12%	110%	—	—	—	
8 Sharp ^{2,3}	8,100	9,880	160	1.6%	184,700	3,000	3/88
Change from 1986	12%	8%	-4%	—	—	—	
9 Canon	7,300	7,814	106	1.3%	208,200	2,800	12/87
Change from 1986	8%	10%	24%	—	—	—	
10 Sanyo	5,700	9,491	-140	-1.5%	233,800	-3,500	11/87
Change from 1986	-14%	0%	-933%	—	—	—	
11 Ricoh ³	4,400	5,200	110	2.2%	185,700	4,000	3/88
Change from 1986	11%	10%	28%	—	—	—	
12 Okai ³	3,900	3,880	40	1.1%	192,600	2,100	3/88
Change from 1986	19%	19%	144%	—	—	—	
13 TDK	3,200	3,186	145	4.5%	199,100	9,000	11/87
Change from 1986	5%	3%	17%	—	—	—	
14 Pioneer	2,900	2,924	91	3.1%	225,000	7,000	3/88
Change from 1986	3%	5%	111%	—	—	—	
15 NTT ²	2,900	45,296	1,946	4.3%	155,600	6,700	3/88
Change from 1986	8%	6%	64%	—	—	—	
16 Alps ²	2,800	2,964	66	2.2%	197,600	4,400	3/88
Change from 1986	0%	0%	107%	—	—	—	
17 Omron	2,400	2,414	166	2.6%	166,500	11,400	3/88
Change from 1986	8%	11%	579%	—	—	—	
18 Kyocera	2,100	2,403	181	7.5%	150,200	11,300	3/88
Change from 1986	12%	9%	30%	—	—	—	
19 Citizen ^{2,3}	2,000	2,200	40	1.8%	262,800	4,700	3/88
Change from 1986	7%	4%	46%	—	—	—	
20 Casio ³	2,000	2,040	40	1.8%	264,200	4,700	3/88
Change from 1986	7%	12%	57%	—	—	—	

Conversion rate: ¥125 = \$1

¹ Comparisons are with the company's last full fiscal year, ending 11/86 for Matsushita and 10/86 for Sony. Both companies recently changed their fiscal year and released only partial results for the period ending 3/87.

² Consolidation by Japanese accounting conventions, which differ from U.S. Securities and Exchange Commission rules.

³ Preliminary figures before release of final consolidated results.

Source: ELECTRONIC BUSINESS

EC firms have embarked on international crusades to expand their influence. These campaigns could leave unprepared U.S. firms outside the kingdom gates.

Inside the fortress Europe after 1992

BY SHERRY BUCHANAN

Europe's top electronics companies are scrambling to build global empires. They realize that they must expand volume to achieve the economies of scale necessary to finance high-technology growth. With some markets shrinking and competition from the United States and Japan increasing, those businesses that don't look beyond their borders will wind up as also-rans. "The globalization of the technologies and markets which fall within our sphere of operations calls for a worldwide approach to product policy," says C.J. van der Klugt, president of N.V. Philips GL of the Netherlands.

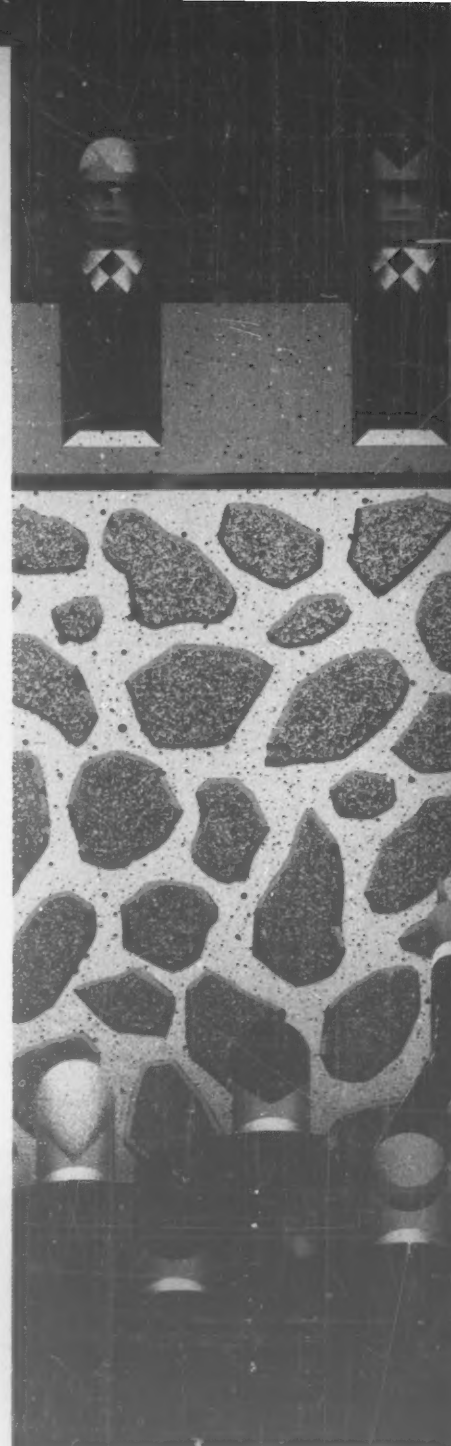
European firms will get a major boost in their international expansion plans in 1992, when the financial and trade barriers between countries are torn down. This will give EEC firms immediate access to a market with more people than the U.S. and about the same gross national product. With the so-called "United States of Europe" less than four years away, many companies have begun to stake out their claims in their expanding home territory.

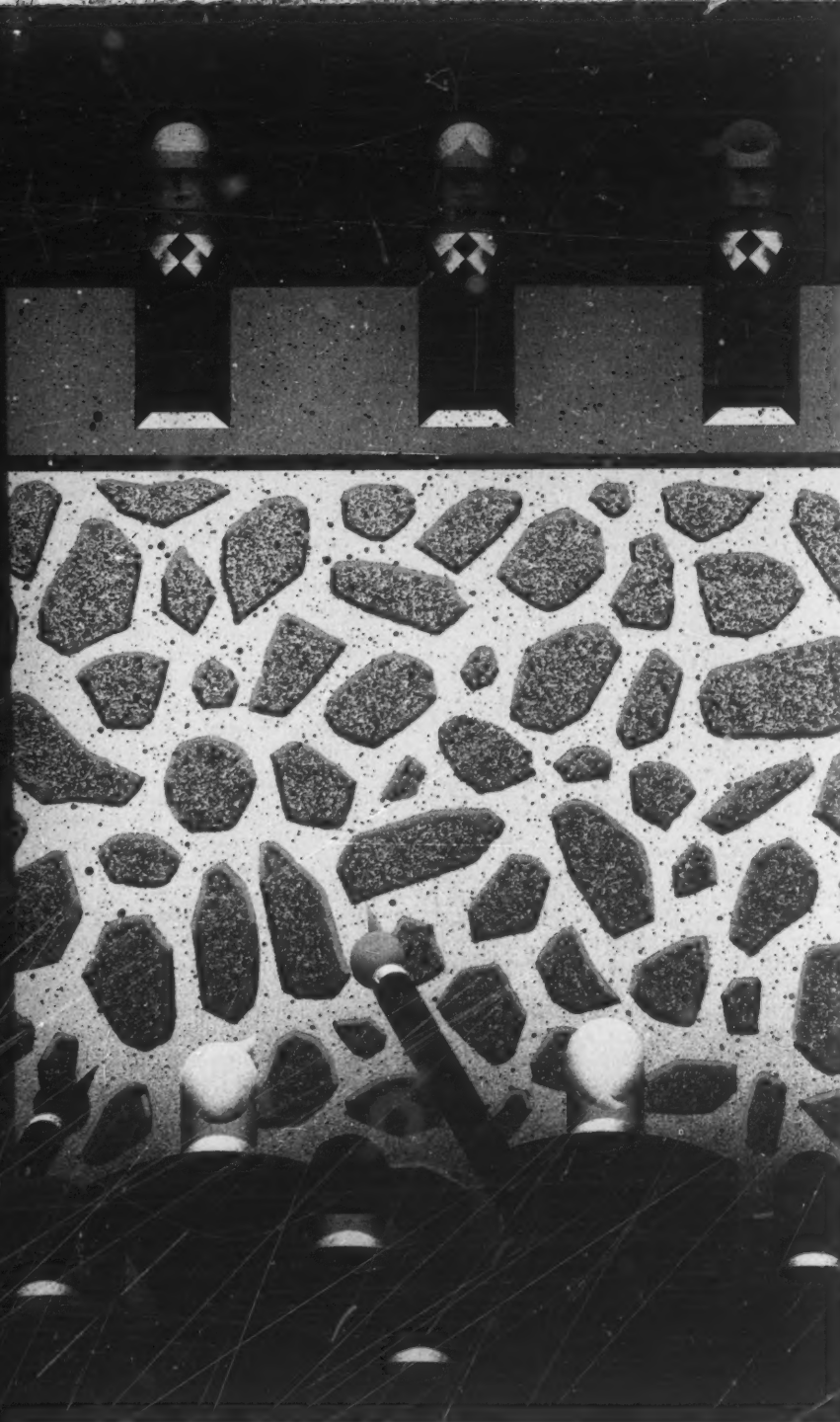
Britain's The Plessey Company Plc, for example, has formed an International Development Group to, in the words of chairman Sir John Clark, "address urgently and vigorously the opportunities presented by this huge new market" and, like others, expand its ties with neighboring companies; in Plessey's case, Elettronica of Italy. "The year 1992 will be a watershed for industry throughout Europe," says Clark. "It will have profound effects on industrial companies."

But many Europeans worry that eliminating internal borders to allow free trade within the Common Market won't be enough. As a result, leading electronics companies may want to build higher walls to keep out non-European products. This worries Peter McPherson, deputy secretary of the U.S. Treasury Department, who is concerned that "an intensification of protectionism" could follow the restructuring.

At least some European firms are expected to lobby for tariffs, quotas and other trade restrictions to keep others out of the post-1992 Euromarket. Philips, for example, wants

the EC action to block Japan from flooding the market with color televisions. Philips has scars from previous wars with the Japanese, notably in video cassette recorders. Philips virtually invented VCRs, but the Japanese came out with a competing standard and Philips had to toe their line. It's not all bad news for outsiders, though. Foreign companies located within the EC borders and those with European partners stand to benefit from the change to a Euromarket. (See related story in this issue on how





to do business in post-1992 Europe.)

In the accompanying tables, ELECTRONIC BUSINESS has ranked the top European electronics companies. This exclusive report is based on careful analysis of the financial statements of the largest companies doing business in Europe. Leading the list are Philips, IBM and Siemens. IBM Europe is consolidating its position as a strong, local company. Philips and Siemens are dramatically restructuring operations to survive in the changing marketplace.

Europe is not without its success stories. Still, much remains to be done if electronics companies want to make the most of the enlarged internal market. A controversial McKinsey & Co. report, published in July, compares British electronics companies with other European, U.S. and Japanese firms, and goes as far as saying that British electronics companies will not "survive" against Japanese, U.S. and some Western European competitors unless they radically change their current strategies.

The report criticizes Britain's electronics sector for relying too much on slow-growing defense and telecommunications business for revenue and also for not having expanded enough either in Europe or other international markets. "British electronics companies must invest to produce the critical mass necessary to be viable competitors in their chosen global markets," says Adair Turner, coauthor of the McKinsey report titled: "Performance and Competitive Success: Strengthening Competitiveness in the U.K. Electronics Industry."

The probability of a significant improvement in Britain's competitive performance — or even the survival of British electronics — looks dim unless major changes are made. The report, for instance, shows that, as a whole, British electronics companies have lost market share even in their home market. In 1976, they accounted for almost half of Britain's sales. By 1986, however, this figure had declined to less than a third.

International rivals

In addition to losing ground in their own home market, they haven't expanded internationally as much as their foreign rivals. As a result, in McKinsey's view, U.S., Japanese and some Western European companies — such as Philips, Thomson-CSF, L.M. Ericsson and Ing. C. Olivetti & Co. — are better prepared to take advantage of the new opportunities of the soon-to-be-borderless Europe. These companies already are present in many of the individual EC markets and have, or are building, management structures suited to running global organizations.

McKinsey argues that some big U.S., Japanese and other Western European companies already generate a larger proportion of their home sales outside their home markets and are truly global companies. Meanwhile, British electronics companies, other than perhaps Racal Electronics and British Aerospace Plc, have not taken a long-term approach and built up their international organizations.

Holland's Philips, for example, sells 93.3% abroad; America's Rank Xerox sells 84.3% outside its home market; Sweden's Ericsson, 78%; Japan's Sony Corp., 70.5%; Italy's Olivetti, 65.7%; and France's Thomson, 60%. Britain's two exceptions, British

Joan Cruz

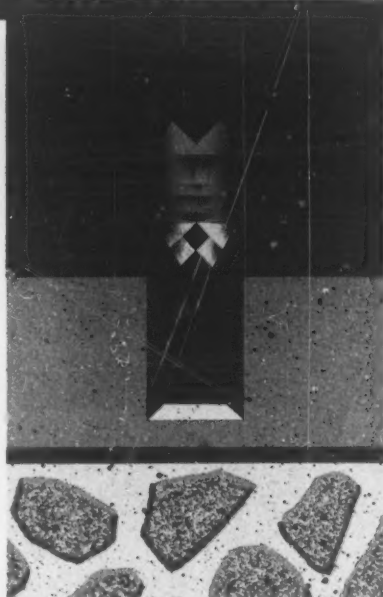
Aerospace and Racal, sell 66% and 60%, respectively, outside their home markets. Germany's giant Siemens AG, meanwhile, could take a lesson from others: It sells only 50% of its product in foreign markets. (Siemens is dramatically changing its strategy, see accompanying story.)

Doomsday scenario

London analysts do not all concur with McKinsey's doomsday scenario. In defense of British electronics companies' slow expansion into other EC countries, analysts point out it is a difficult task to find partners on the continent and that it takes time. "Europeans on the continent are very difficult to acquire," for example, says Miles Saltiel, electronics analyst with Hoare Govett, a London brokerage house. "You need long-term relationships and a lot of them have restricted share practices. A British company can't just go in there and do a hostile takeover."

At least one British firm targeted in the report's criticism, is currently reorganizing. Britain's General Electric Co. (GEC, no relation to the U.S. General Electric), which has operated with 120 independent subsidiaries, is centralizing control to ensure the convergence of new technologies. "So much of McKinsey's report seems to be aimed at GEC without specifically saying so," says Philip Hughes, chairman of Logica Plc, the British software house. "And the approach of having very decentralized development activities does make it very difficult to launch strategic initiatives."

Overpowering tough competitors abroad is proving a difficult task for some of the big European electronics companies—even those that are ahead of the game, relative to the British. Price pressures in the consumer electronics sector and competition from low-cost producers such as the Koreans have forced the major European companies to merge or be acquired. Last year, England's Plessey and GEC combined their strengths in telecommunications; Plessey expanded its stake in Elettronica to 49%; and Sweden's Asea AB and West Germany's BBC Brown Boveri merged the worldwide electrical engineering activity. It is essential "to utilize the global economies of scale" and focus on "growth ambitions in Europe and transoceanic countries," according to Percy



"The restructuring of the European market could possibly lead to an intensification of protectionism"

Barnevik, Asea president and CEO.

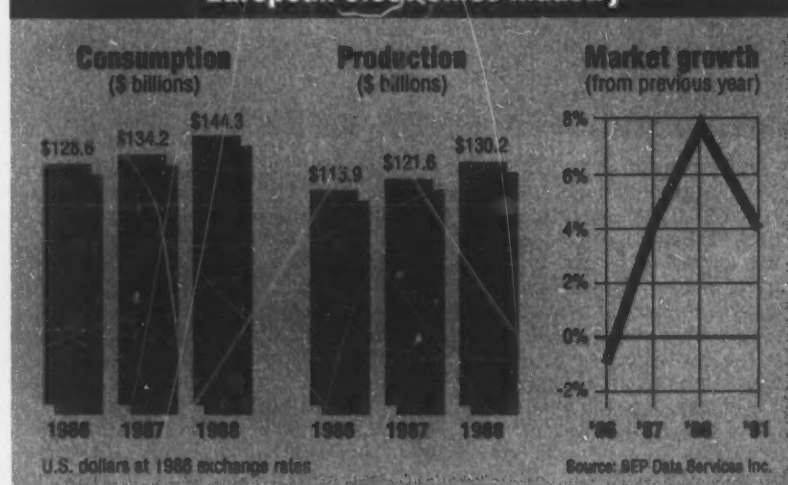
Meanwhile, Philips, which employs 340,000 worldwide, is facing the difficult task of going through a massive internal reorganization to cut costs by 800 million guilders (or \$374 million—in late August, 2.14 guilders=\$1) this year. In Europe, Philips says it will cut middle management by 20,000 people. During the next five to 10 years, it will close 70 European plants. Philips has already laid off 6,000 European employees and expects between 4,000 and 14,000 more job losses. Like

GEC, Philips in the past relied on fiercely independent national subsidiaries. As part of the move to tighten control over national organizations, Philips has just named Geerit Jeelof, formerly vice chairman of the board of management, to head its U.S. operation.

"Philips is a microcosm of the whole industry and a very good indicator of what's going on in other places," says Angela Dean, analyst at Robert Fleming Securities Ltd., a London brokerage house. For example, at the end of July, Philips' second quarter net profit plunged 44%, an unexpectedly poor showing which sent stock down. Many analysts had expected Philips' earnings to be about equal to last year's, at 818 million guilders, or \$382 million. Philips is Western Europe's biggest maker of semiconductors and consumer electronics products. Turnover has fallen steadily since 1985 and profit margins in the 1980s are not what they were in the 1960s.

"Our major task is to find an answer to what is the most pressing problem in consumer electronics, and that is constant price erosion," says Jan Timmer, Philips board member responsible for consumer electronics. "We have two to three years to know whether Philips will be able to make it in consumer electronics." Philips blames Japanese and Korean dumping. But, contends Pat Meagher-Davis, European electronics analyst with James Capel and Company, in London: "Antidumping measures

European electronics industry



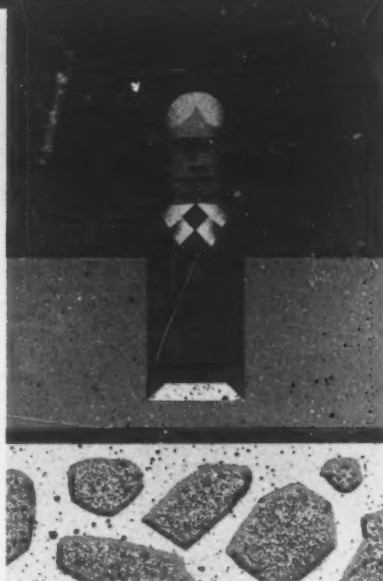
wouldn't solve the problem, it would only buy them time."

Philips, meanwhile, is rationalizing production, closing European plants and transferring manufacturing to the Far East. Executives say this shift will continue. Philips says survival depends on taking advantage of economies of scale and becoming a low-cost producer. The Dutch giant already has 27,000 employees and 25 plants in Japan, Hong Kong and other Asian countries and plans to shift more production there, as well as to Mexico. In Asia, Philips already manufactures black-and-white televisions, radios and video cassette recorders, which it sells worldwide. Philips also has plans to expand product development and engineering activities in the Far East.

Computer firms hold out

Despite this flurry of activity around the world, the majority of European computer makers are staying closer to home for the time being, although some of the larger players like Siemens are likely to increase their size and expand in European markets and, eventually, the United States. Others, like West Germany's Nixdorf Computer AG are, however, eyeing the world markets — with some success.

"It is going to get very hot in the computer sector, where not much restructuring has happened yet, and life is quite difficult," says Dean of Robert Fleming. "Too many companies are competing in a market that



The post-1992 Euromarket will have more people than the U.S. and about the same gross national product

is dominated by United States suppliers." American computer companies remain strong market leaders in the European market, according to Dataquest. IBM has 56% of the European market in corporate resource computers (computers which cost more than \$1 million). Digital Equipment Corp. is the leader in business unit computers with 20% of the European market (computers which cost between \$75,000 and \$250,000).

Eventually, industry observers say, European computer companies will reorganize through mergers and acquisitions. Margins are being squeezed, market growth has slowed and most European companies are small relative to the giant United States firms. "We will see a lot of M&A activity — especially between hardware and software companies," says Meagher-Davis. "And a lot of those companies are cheap."

According to Meagher-Davis, European companies should be well placed to take advantage of what she calls the "microcomputer application." You can't sell people just a box anymore, you have to sell them the total solution," she says. "Unlike the U.S. companies, European companies — Nixdorf is a prime example — have grown up that way." Some consolidation has already taken place between suppliers of hardware.

In January of last year, Siemens and BASF combined their IBM-

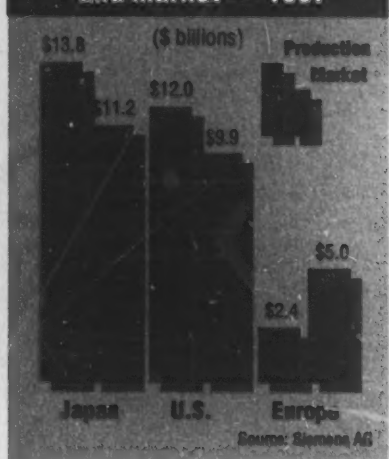
compatible mainframe businesses to create Comparex, with sales of \$500 million. And in March 1987, France's Groupe Bull, the United States' Honeywell Inc. and Japan's NEC Corp. created an organization with sales worth \$2.1 billion. Britain's STC, which bought ICL, the British computer company, is currently looking for software houses to buy in West Germany.

As European companies restructure to secure their soon-to-be-expanded European home market, analysts also predict they will become more active in the U.S. market. In July, Siemens, the German electronics concern, signed an agreement to acquire a majority interest in Allied-Signal Inc.'s Bendix automotive electronics group for some \$250 million. In the last few months, Siemens has set up ventures with Intel Corp. in microcomputers; Advanced Micro Devices Inc. in telecommunications and semiconductors; and Westinghouse Electric Corp. in factory automation and industrial controls.

According to analysts, there have been few moves by either U.S. or Japanese companies to acquire European firms. The United States' General Electric Co. did, however, take on Thomson-CGR, Thomson's medical systems business, as part of a deal whereby Thomson acquired GE's consumer electronics business. "If you look at computers and consumer electronics, the U.S. and Japanese companies are already significant competitors. The fight will be in public telecommunications. I don't think the European companies are badly placed," says Dean. "It suddenly may look a lot easier to the U.S. and Japanese companies to come into a big market, the European internal market. But there are opportunities on both sides."

The success story on everyone's mind is Ericsson. "For really good companies, the liberalization of telecommunications buying practices and the impending advent of 1992 will be a challenge," says Dean. "Just look what Ericsson did. It realized it couldn't survive in just Sweden, so it took advantage of the opening of the world telecommunications markets." Ericsson, which was an early leader in public switching systems, has captured 40% of the world cellular radio market. Others dream of similar success stories. □

Worldwide IC production and market — 1987



Top European electronics companies

Rank	Company	Electronics sales (\$ millions)	Electronics sales as a percentage of total sales	Total consolidated sales (\$ millions)	Profit before tax as a percentage of sales	Profit after tax as a percentage of sales	Sales per employee	Profit before tax per employee
1	Philips	\$18,825	72%	\$25,968	1.9%	1.5%	\$77,125	\$1,488
2	IBM	18,332	34%	54,217	15.9%	9.7%	139,251	22,111
3	Siemens	15,098	55%	27,503	5.1%	2.5%	76,611	3,870
4	CGE	12,770	60%	21,208	3.9%	2.5%	96,620	3,808
5	Thomson	9,012	90%	10,014	4.4%	1.8%	116,438	5,069
6	GEC	5,756	61%	9,457	12.7%	8.1%	60,136	7,667
7	Olivetti	5,121	90%	5,688	7.3%	5.5%	NA	NA
8	Ericsson	4,238	83%	5,102	3.4%	2.3%	71,973	2,461
9	Robert Bosch	3,954	28%	14,092	6.9%	3.3%	87,340	5,987
10	Xerox	3,325	32%	10,320	8.1%	5.6%	104,209	8,482
11	DEC	3,253	35%	9,389	18.0%	12.1%	84,972	15,284
12	STC	3,147	93%	3,388	9.1%	6.0%	97,054	8,829
13	STET	3,113	26%	11,972	9.3%	7.2%	96,315	8,947
14	Groupe Bull	3,007	100%	3,007	1.1%	1.2%	114,169	1,260
15	Nixdorf	2,817	100%	2,817	6.5%	5.2%	95,687	6,238
16	British Telecom	2,805	16%	17,346	22.5%	14.3%	73,125	16,456
17	Hewlett-Packard	2,667	33%	8,090	11.9%	8.0%	98,659	11,732
18	Unisys	2,400	25%	9,713	9.8%	6.0%	105,004	10,243
19	AEG	2,333	36%	6,478	0.7%	0.0%	80,972	576
20	Sony	2,290	22%	10,347	5.1%	2.6%	171,025	8,783
21	Matsushita	2,233	6%	34,839	8.9%	3.4%	259,632	23,232
22	Plessey	2,216	100%	2,216	13.2%	9.1%	73,512	9,725
23	Racal	2,113	91%	2,328	10.1%	6.6%	72,970	7,370
24	Canon	2,058	30%	6,753	4.1%	1.4%	179,984	7,415
25	NCR	1,797	32%	5,641	13.5%	7.4%	90,979	12,297
26	Nokia	1,499	47%	3,174	9.0%	6.0%	NA	NA
27	Grundig	1,524	100%	1,524	4.9%	3.5%	78,241	3,844
28	Thorn EMI	1,352	26%	5,201	7.4%	4.8%	81,268	5,995
29	Schlumberger	1,300	30%	4,402	14.1%	11.4%	88,040	12,371
30	Motorola	1,200	18%	6,707	6.2%	4.6%	68,649	4,258
31	Ferranti	1,121	80%	1,400	8.3%	5.6%	56,414	4,666
32	Control Data	1,119	33%	3,367	1.7%	0.7%	97,580	1,664
33	Bayer	1,111	5%	20,635	8.3%	4.2%	125,517	10,361
34	Mannesmann	1,083	12%	9,253	1.7%	0.8%	81,685	1,365
35	Honeywell	1,005	15%	6,679	6.2%	3.8%	84,676	5,222

NA = Not available

Electronics sales: Represents ELECTRONIC BUSINESS' estimate of the revenue earned by each company from the sale of electronics products.

The figure shown is based on the latest available completed fiscal year, thus a variety of accounting periods are represented.

Similarly, the electronics sales and other

financial information have been converted to dollars using an exchange rate that consists of the average rate during each company's fiscal year.

For European companies, the figure shown is their worldwide sales of electronics products, including those manufactured and sold outside Europe; for non-European companies the figure estimates their electronics sales in Western Europe only.

Electronics as a percentage of total sales: Indicates the proportion of electronics products within the total consolidated sales of all the products of the company. For firms not European owned, the percentage relates to their electronics sales in Western Europe as a percentage of total consolidated worldwide sales.

Profit after tax per employee	Fixed assets per employee	Investments as a percentage of sales	Return on gross capital employed	R&D as a percentage of sales	Capital expenditures as a percentage of sales	Current ratio	Fiscal year ended	Country of origin
\$1,182	\$27,048	16.0%	3.2%	8.3%	7.7%	1.49	12/87	Netherlands
13,505	58,873	18.0%	17.1%	10.0%	7.9%	2.32	12/87	U.S.
1,900	19,989	21.3%	5.9%	12.1%	9.2%	3.73	9/87	West Germany
2,367	14,624	11.7%	7.5%	7.8%	3.9%	1.28	12/87	France
2,057	19,555	14.7%	8.4%	6.3%	8.4%	1.14	12/87	France
4,882	8,930	17.1%	20.8%	12.1%	5.0%	2.11	3/88	Britain
NA	NA	NA	NA	0.7%	NA	NA	12/87	Italy
1,633	15,057	14.8%	5.2%	9.9%	4.9%	2.02	12/87	Sweden
2,839	13,905	13.6%	18.0%	5.6%	7.9%	2.08	12/87	West Germany
5,836	25,416	16.1%	11.0%	7.0%	9.1%	1.56	12/87	U.S.
10,293	19,252	18.7%	26.0%	10.8%	8.0%	3.40	6/87	U.S.
5,809	15,582	14.2%	25.0%	8.5%	5.7%	1.70	12/87	Britain
6,931	191,272	NA	NA	NA	35.8%	NA	12/87	Italy
1,423	39,737	21.1%	1.8%	8.6%	12.5%	1.60	12/87	France
4,985	29,278	23.4%	9.7%	9.4%	14.0%	2.36	12/87	West Germany
10,475	87,234	25.1%	19.4%	1.9%	23.2%	0.90	3/88	Britain
7,854	28,390	17.4%	18.9%	11.1%	6.3%	2.01	10/87	U.S.
6,249	22,929	13.6%	24.3%	6.1%	7.4%	1.33	12/87	U.S.
0	12,354	13.3%	1.3%	8.0%	5.4%	4.38	12/87	West Germany
4,390	50,942	18.2%	10.7%	8.9%	9.3%	1.14	3/88	Japan
8,773	29,301	9.3%	12.9%	5.6%	3.6%	2.15	3/88	Japan
6,708	13,528	12.6%	21.4%	7.2%	5.3%	1.50	3/88	Britain
4,781	20,367	9.8%	19.3%	NA	9.8%	1.53	3/88	Britain
2,441	43,606	12.3%	6.6%	5.8%	6.5%	1.73	12/87	Japan
6,763	17,068	13.2%	33.7%	6.3%	6.9%	1.72	12/87	U.S.
NA	NA	NA	NA	NA	NA	NA	12/87	Finland
2,751	10,686	9.9%	19.9%	3.4%	6.5%	1.25	3/87	West Germany
3,893	24,828	14.2%	21.1%	1.1%	13.1%	1.09	3/88	Britain
10,051	33,407	14.3%	15.1%	8.0%	6.3%	1.66	12/87	Netherlands Antilles
3,153	23,838	17.6%	12.4%	7.8%	9.8%	1.62	12/87	U.S.
3,136	17,094	10.1%	15.6%	4.9%	5.2%	1.31	3/88	Britain
722	17,675	16.9%	4.3%	11.6%	5.3%	1.63	12/87	U.S.
5,218	34,962	13.1%	24.1%	6.2%	6.9%	1.26	12/87	West Germany
656	19,785	6.2%	4.0%	2.2%	4.0%	1.42	12/87	West Germany
3,216	17,454	9.0%	18.0%	4.3%	4.7%	1.24	12/87	U.S.

Fixed assets per employee: Shows the accumulated value (less depreciation) of land, buildings, plant, machinery, furniture and fittings (including rental equipment) that the company has invested per employee.

Investments as a percentage of sales: Adds together capital expenditures and research and development as a proportion of total consolidated sales.

Return on gross capital employed: Shows profit before taxes as a proportion of net working capital plus fixed assets and investment (for example, equity holdings and other assets, not capital expenditures).

Capital expenditures as a percentage of sales: Shows the amount of new investment in fixed assets during the year as a proportion of total consolidated sales.

Current ratio: Shows current assets as a proportion of current liabilities, giving a rough indication of the liquidity of the company.

Country or origin: Indicates the country in which the company is ultimately registered.

Source: ELECTRONIC BUSINESS

Sales-growth speedsters: Make way for a new generation

1987 was the year the workstation came of age, with Sun Microsystems topping the list of fastest growing companies

BY BRUCE C.P. RAYNER AND
BY LINDA STALLMANN

It should come as no surprise that Sun Microsystems Inc. is the top-growth electronics company for 1987. With a five-year compounded growth rate of 474%, the \$537 million workstation company sets a new record in the ELECTRONIC BUSINESS survey of the 100 fastest growing companies, now in its fourth year. By most accounts, Sun is destined for the billion-dollar club by the end of 1988.

Part of the reason for Sun's stellar performance is the growth of the workstation market itself. Computer-aided engineering workstations hardly existed at the beginning of the decade, but by 1987, reports market research firm Dataquest Inc., total worldwide revenue for workstations had reached \$17 billion. The other component of Sun's growth comes from the corporate commitment to

industry standards and open systems: "Everybody wants them," says Joseph Roebuck, Sun's vice president for sales. This commitment has earned Sun a 33% market share in 1987, up from 20% in 1986, a gain that Roebuck characterizes as "phenomenal."

But Sun is not the only benefactor of the workstation boom: fifth-ranked Mentor Graphics Corp., maker of engineering design systems, posted record sales and profits in 1987; 12th-placed Apollo Computer Inc., one of Sun's main competitors, has had five-year compounded growth at just under 100%; and CAE vendor Daisy Systems Corp., 15th on the list, boosted sales for a five-year average of 85.7%, despite its recent

slow growth and losses in both 1986 and 1987. Gerard Langelier, president of Mentor, acknowledges that demand for workstations has contributed to his company's success, but insists that software is also important. "There is no workstation market without the applications to run on them," he says.

Just because workstation makers are in a fast-paced industry does not mean they have a monopoly on growth. Software, personal computers, chips and peripherals all are represented in the top echelons of the ELECTRONIC BUSINESS growth list. In fact, when taken as an industry segment, software was the leading performer in 1987. Sales of software grew at a rate of 64.3%, while profits grew at 84.6%. Second-ranked Lotus Development Corp., maker of the 1-2-3 database program, beat the average by over five times, posting an average sales growth rate of 369%. Peripherals makers came second, with average sales growth of 47.4%.

"I think the No. 1 reason for growth," admits Q.T. Wiles, chairman of sixth-placed MiniScribe Corp., a \$362 million maker of rigid disk drives, "is that we are in a fast-growing industry." Also important are good management — MiniScribe employs a divisionalized style as opposed to a functional management style — tight cost control and being market-, not technology-driven, he adds. MiniScribe was at the top of the list last year, posting 369.5% average growth.

Calling California home

One significant trend gleaned from this list is the fact that 41 of these companies call California home. The number has been slowly but steadily inching up over the years. The closest competitor is Massachusetts, with 14 resident companies. In the future,

Top 10 fastest growing companies

1987 rank	Company	Market	5-year sales growth	Fiscal 1987 sales (\$ millions)
1	Sun Microsystems	Workstations	474.4%	\$537.5
2	Lotus Development	PC software	369.2%	395.6
3	AST Research	Boards and PCs	249.5%	206.0
4	Iomega	Floppy disks	185.2%	89.4
5	Mentor Graphics	CAE systems	164.1%	221.8
6	MiniScribe	Rigid disks	135.1%	362.5
7	Symbolics	AI systems	125.0%	103.8
8	Oracle	Database software	121.3%	131.3
9	LSI Logic	Gate array chips	121.0%	262.1
10	Wyse Technology	Terminals and PCs	102.9%	260.0

Source: ELECTRONIC BUSINESS



Driven by design: Heading some of the fastest growing companies are, from left: Daisy's Norman Friedmann; Apollo's Thomas Vanderslice; Mentor's Thomas Bruggere; and Sun's Scott McNealy

look to Texas to spawn high-growth companies. *Inc. Magazine* recently ranked Austin, Texas, the fastest growing city in the United States, partly because it won the sweepstakes to woo the Sematech semiconductor industry consortium. Also, Houston has started a campaign to become the next aerospace capital of America, after Southern California.

As with most previous years, the common thread in the top-growth companies is youth. In the top 10 this year, the oldest entrant is eighth-ranked Oracle Corp., a database management software company formed a decade ago. All other companies were established in the 1980s.

In order to qualify for ELECTRONIC BUSINESS' top 100 fast-growth list, a company must have reported sales for the past six years, with 1987 sales reaching at least \$80 million. Also, the company must be U.S.-based and

publicly held, with at least 70% of its total sales in electronics.

The six-year sales figure criterion was the disqualifier for Compaq Computer Corp. Compaq, the second-largest business personal computer maker in the world, behind IBM, was formed in 1982 but did not start shipping product until January 1983. It broke a first-year sales record by pulling in \$111 million and has not looked back since. In 1987 the company nearly doubled its 1986 revenue by selling \$1.2 billion worth of computers.

Michael Swavely, Compaq's vice president for sales, puts the company's performance down to the fact that Compaq has always considered itself a large company, even as a start-up. "In our part of the industry, you have to be a large company to compete," Swavely says. For 1988, he expects the company to outpace the

forecast industry growth rate of 20%.

While growth is by definition faster when the company is just starting out, there are 12 billion dollar companies that make an appearance in the ELECTRONIC BUSINESS fastest growing 100: leading the pack is \$2.7 billion Apple Computer Inc., at No. 41. Between heavy hitters Digital Equipment Corp. and Unisys Corp., it was a close call for 71st and 72nd place. Both Digital and Unisys are players in the workstation market, with DEC producing its own boxes and Unisys reselling the Sun system.

Where's IBM?

One mega-company conspicuous by its absence is IBM. For the past few years, Big Blue has been steadily climbing from 88th place in 1985 to 76th place last year. But because of lagging sales growth last year, IBM's 1987 five-year growth rate fell to

9.5% for the year, down from its 1986 figure of 12%. But this slowing growth figure is deceptive. In total, IBM boosted sales by \$2.96 billion last year, an enviable figure for any company that made the list.

The key to growth, say top performers, is a combination of elements: being young means you are aggressive and that is essential; having a good distribution system means product gets to market faster; an ability to differentiate yourself from the pack technically helps in the battle for market share; a willingness to take some calculated — and some not so calculated — risks usually accelerates growth; and being in the right place at the right time always helps.

"Our growth is based on common-sense business tactics that keep the company going with a solid foundation," says Thomas Yuen, vice president for marketing and one of three

founders of third-ranked AST Research Inc. Yuen has helped to guide AST from the add-in board business into a premier desktop computer systems house. Looking back on the transition period, Yuen says the biggest problem has been production capacity. "The capacity we initially forecast was way below what we can satisfy," he says.

Bernard Tse, chairman and chief executive of 10th-placed terminal maker Wyse Technology, says his strategy is no secret: "We picked a market that is enormous and tried to be very competitive." Tse claims both a cost advantage and a price advantage and "with a little bit of luck we have been able to grow very fast." But the company's luck may have limits. Seven-year-old Wyse is operating in a business that is actually shrinking, a worrisome phenomenon to a growth-oriented company. Da-

taquest estimates that the worldwide terminal market contracted to \$3.5 billion last year, down from \$3.9 billion in 1986. Still, Wyse grew its market share in 1987 from 14% to 17%, the only terminal maker to do so.

Two top-growth companies in less than robust health are Iomega Corp. and Symbolics Inc. Iomega, a maker of floppy disk drives, has reported a net loss of \$36.7 million for calendar 1987 as a result of a decline in demand, substantial reduction in inventory level and slower than anticipated acceptance of the company's new 5.25 product. Symbolics, a manufacturer of symbolic processing systems for technical and artificial-intelligence workstations, reported a net loss of \$25.5 million in fiscal 1987, ending June 30, and losses of \$19.9 million for the first half of fiscal 1988. The company is in a restructuring mode to pare down operations.

1987's fastest-growing companies by segment

	5-year sales growth	5-year profit growth	1987 rank
Software			
Lotus Development	369.2%	NM	2
Oracle	121.3%	124.7%	8
Ashton-Tate	71.3%	109.4%	17
Microsoft	69.8%	82.9%	18
Ultimate	42.1%	36.6%	34
Cullinet Software	28.8%	NM	47
Weighted average	64.3%	84.6%	

	5-year sales growth	5-year profit growth	1987 rank
Peripherals			
Iomega	185.2%	NM	4
MiniScribe	135.1%	NM	6
Wyse Technology	102.9%	NM	10
Seagate Technology	88.3%	82.3%	14
Archive	69.7%	NM	19
QMS	67.4%	38.5%	2
Quantum	54.6%	116.3%	2
Micropolis	54.3%	218.6%	2
Lee Data	53.0%	34.6%	2
Intelligent Systems	46.0%	NA	30
Emulex	44.9%	10.8%	31
Xidex	42.5%	NM	33
Priam	34.0%	NM	42

	5-year sales growth	5-year profit growth	1987 rank
Peripherals (continued)			
Cipher Data Products	25.1%	12.7%	55
Applied Magnetics	18.0%	9.7%	77
Printtronix	13.8%	NM	93
Weighted average	49.9%	33.3%	

	5-year sales growth	5-year profit growth	1987 rank
Computer-based systems			
Mentor Graphics	164.1%	NM	5
Daisy Systems	85.7%	NM	15
Mark IV Industries	67.6%	72.3%	21
Intergraph	32.7%	40.0%	44
Ask Computer Systems	31.6%	24.3%	46
Data Card	26.9%	-15.2%	53
ISC Systems	22.1%	-4.2%	60
Evans-Sutherland	20.1%	8.5%	64
Recognition Equipment	18.7%	NM	75
Coherent	14.6%	NM	85
Measurex	14.0%	NM	89
Computer Consoles	13.4%	5.3%	96
Weighted average	27.9%	42.7%	

(Continued)

NA = Not available

NM = Not meaningful, company had a loss in one of the base years

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1987's fastest-growing companies by segment

	5-year sales growth	5-year profit growth	1987 rank
Computers			
Sun Microsystems	474.4%	NM	1
Symbolics	125.0%	NM	7
Stratus Computer	101.9%	NM	11
Apollo Computer	98.2%	134.3%	12
Kaypro	80.9%	NM	16
SCI Systems	43.8%	31.2%	32
Cray Research	37.2%	50.6%	38
Apple Computer	35.5%	28.8%	41
Telex	32.3%	45.8%	45
Tandem Computers	27.1%	28.7%	51
Amdahl	26.6%	96.3%	54
Aitos Computer Systems	24.7%	11.1%	56
Wang Laboratories	19.6%	NM	67
DEC	19.3%	22.2%	71
Unisys	18.9%	33.4%	72
Prime Computer	17.1%	7.6%	80
Tandy	13.5%	1.6%	94
Weighted average	21.6%	20.6%	

Semiconductors			
LSI Logic	121.0%	NM	9
Micron Technology	94.4%	NM	13
Western Digital	69.3%	NM	20
VLSI Technology	52.0%	NM	28
Silicon Systems	38.5%	14.3%	36
Burr-Brown	19.8%	16.3%	65
Advanced Micro Devices	19.5%	NM	68
Analog Devices	16.3%	13.6%	82
Intel	16.2%	52.5%	83
Siliconix	15.3%	40.2%	84
Weighted average	22.4%	43.2%	

Distributors			
Anthem Electronics	38.5%	27.0%	37
Marshall Industries	19.4%	NM	70
Pioneer-Standard Electronics	17.5%	-4.4%	79
Wyle Laboratories	13.4%	NM	95
Weighted average	18.9%	144.9%	

Communications			
Digital Communications Assoc.	66.5%	107.0%	23
Regency Electronics	49.5%	36.8%	29
Timeplex ¹	35.5%	NA	39
DSC Communications	35.5%	16.7%	40
Micom Systems	27.8%	9.0%	49
Bolt Beranek and Newman	27.6%	NM	50
General DataComm Industries	27.0%	NM	52
Dynatech	23.7%	30.3%	58
Cincinnati Microwave	22.9%	17.6%	59
ADC Telecommunications	21.8%	26.9%	61
Avantek	20.6%	4.3%	63
Motorola	12.1%	12.6%	100
Weighted average	15.8%	15.1%	

Defense			
Electrospace Systems	28.2%	18.3%	48
Loral	19.6%	17.2%	66
Logicon	18.9%	14.1%	73
AEL Industries	18.8%	52.8%	74
Varo	13.9%	8.5%	91
Weighted average	20.0%	17.3%	

Capital equipment			
LTX	20.7%	NM	62
Teradyne	16.5%	NM	81
Gerber Scientific	14.2%	44.0%	87
Hewlett-Packard	14.1%	11.0%	88
Applied Materials	13.9%	NM	90
Nicolet Instruments	13.3%	3.0%	97
Weighted average	14.2%	10.6%	

Components (other than semiconductors)			
Molex	18.5%	15.9%	76
AVX	17.7%	38.8%	78
AMP	13.3%	16.0%	98
Cherry	12.3%	-8.5%	99
Weighted average	14.1%	16.2%	

¹ Acquired by Unisys Corp. Jan 22, 1988

NA = Not available

NM = Not meaningful, company had a loss in one of the base years

(Continued)

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1987's fastest-growing companies

1987 rank	Company	5-year sales growth	Fiscal 1987 sales (\$ millions)	Fiscal 1987 profits (\$ millions)	Fiscal year ended	Location
1	Sun Microsystems	474.4%	\$537.5	\$36.3	3/87	Mountain View, Calif.
2	Lotus Development	369.2%	395.6	72.0	12/87	Cambridge, Mass.
3	AST Research	249.5%	206.0	13.0	6/87	Irvine, Calif.
4	Iomega	185.2%	89.4	-36.7	12/87	Roy, Utah
5	Mentor Graphics	164.1%	221.8	20.3	12/87	Beaverton, Ore.
6	MiniScribe	135.1%	362.5	31.1	12/87	Longmont, Colo.
7	Symbolics	125.0%	103.8	-25.5	6/87	Cambridge, Mass.
8	Oracle	121.3%	131.3	15.6	3/87	Belmont, Calif.
9	LSI Logic	121.0%	262.1	10.7	12/87	Milpitas, Calif.
10	Wyse Technology	102.9%	260.0	18.1	3/87	San Jose, Calif.
11	Stratus Computer	101.9%	184.2	19.4	12/87	Marlboro, Mass.
12	Apollo Computer	98.2%	553.7	21.7	12/87	Chelmsford, Mass.
13	Micron Technology	94.4%	91.2	-22.9	8/87	Boise, Idaho
14	Seagate Technology	88.3%	958.1	139.7	6/87	Scotts Valley, Calif.
15	Daisy Systems	85.7%	100.9	-16.3	9/87	Mountain View, Calif.
16	Kaypro	80.9%	105.6	-9.6	8/87	Solana Beach, Calif.
17	Ashton-Tate	71.3%	267.3	43.1	1/88	Torrance, Calif.
18	Microsoft	69.8%	345.9	71.9	6/87	Redmond, Wash.
19	Archive	69.7%	88.8	6.1	9/87	Costa Mesa, Calif.
20	Western Digital	69.3%	462.5	42.8	6/87	Irvine, Calif.
21	Mark IV Industries	67.6%	291.5	10.2	2/87	West Amherst, N.Y.
22	QMS	67.4%	119.4	8.7	9/87	Mobile, Ala.
23	Digital Communications	66.5%	181.4	27.0	6/87	Alpharetta, Ga.
24	Emerson Radio	56.0%	810.1	26.6	3/87	North Bergen, N.J.
25	Quantum	54.6%	120.8	8.8	3/87	Milpitas, Calif.
26	Micropolis	54.3%	288.3	27.2	12/87	Chatsworth, Calif.
27	Lee Data	53.0%	114.5	5.4	3/87	Minneapolis, Minn.
28	VLSI Technology	52.0%	172.0	8.1	12/87	San Jose, Calif.
29	Regency Electronics	49.5%	495.3	24.3	6/87	Indianapolis, Ind.
30	Intelligent Systems ¹	46.0%	163.0	NA	12/87	Norcross, Ga.
31	Emulex	44.9%	103.8	3.5	6/87	Costa Mesa, Calif.
32	SCI Systems	43.8%	552.9	16.0	6/87	Huntsville, Ala.
33	Xidex	42.5%	572.8	-44.5	6/87	Mountain View, Calif.
34	Ultimate	42.1%	172.9	13.8	4/87	East Hanover, N.J.
35	Data Switch	39.7%	96.9	2.3	12/87	Shelton, Conn.
36	Silicon Systems	38.5%	81.8	2.8	9/87	Tustin, Calif.
37	Anthem Electronics	38.5%	196.9	5.0	12/87	San Jose, Calif.
38	Cray Research	37.2%	687.3	147.1	12/87	Minneapolis, Minn.
39	Timeplex ²	35.5%	147.2	NA	6/87	Woodcliff Lake, N.J.
40	DSC Communications	35.5%	312.4	14.6	12/87	Plano, Texas
41	Apple Computer	35.5%	2,661.1	217.5	9/87	Cupertino, Calif.
42	Priam	34.0%	129.6	-41.3	6/87	San Jose, Calif.
43	Network Systems	33.5%	120.5	17.5	12/87	Minneapolis, Minn.
44	Intergraph	32.7%	641.1	69.9	12/87	Huntsville, Ala.
45	Telex	32.3%	840.7	77.9	3/87	Tulsa, Oklahoma
46	Ask Computer Systems	31.6%	98.3	8.0	6/87	Los Altos, Calif.
47	Cullinet Software	28.8%	174.9	-27.6	4/87	Westwood, Mass.
48	ElectroSpace Systems	28.2%	190.7	10.1	3/87	Richardson, Texas
49	Micom Systems	27.8%	196.7	12.2	3/87	Simi Valley, Calif.
50	Bolt Beranek and Newman	27.6%	233.8	-8.0	6/87	Cambridge, Mass.

¹ Estimate by INP 2/22

NA = Not available

² Acquired by Unisys Corp. Jan. 22, 1988

(continued)

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1987's fastest-growing companies

1987 rank	Company	5-year sales growth	Fiscal 1987 sales (\$ millions)	Fiscal 1987 profits (\$ millions)	Fiscal year ended	Location
51	Tandem Computers	27.1%	\$1,035.5	\$105.6	9/87	Cupertino, Calif.
52	General DataComm Industries	27.0%	200.6	0.8	9/87	Middlebury, Conn.
53	Data Card	26.9%	176.1	1.6	3/87	Minneapolis, Minn.
54	Amdahl	26.6%	1,505.2	142.0	12/87	Sunnyvale, Calif.
55	Cipher Data Products	25.1%	178.2	4.3	6/87	San Diego, Calif.
56	Altos Computer Systems	24.7%	153.9	9.7	6/87	San Jose, Calif.
57	Diceon Electronics	23.8%	111.1	9.5	9/87	Irvine, Calif.
58	Dynatech	23.7%	304.7	23.2	3/87	Burlington, Mass.
59	Cincinnati Microwave	22.9%	80.9	12.3	12/87	Cincinnati, Ohio
60	ISC Systems	22.1%	168.5	6.5	6/87	Spokane, Wash.
61	ADC Telecommunications	21.8%	166.9	15.3	10/87	Bloomington, Minn.
62	LTX	20.7%	120.6	-6.7	7/87	Westwood, Mass.
63	Avantek	20.6%	213.7	11.6	12/87	Santa Clara, Calif.
64	Evans-Sutherland	20.1%	134.4	14.7	12/87	Salt Lake City, Utah
65	Burr-Brown	19.8%	140.5	4.3	12/87	Tucson, Ariz.
66	Loral	19.6%	690.0	57.5	3/87	New York, N.Y.
67	Wang Laboratories	19.6%	2,836.7	-70.7	6/87	Lowell, Mass.
68	Advanced Micro Devices	19.5%	997.1	-48.1	12/87	Sunnyvale, Calif.
69	Diasonics	19.5%	267.6	15.2	12/87	South San Francisco, Calif.
70	Marshall Industries	19.4%	286.6	5.1	5/87	El Monte, Calif.
71	DEC	19.3%	9,389.4	1,137.4	6/87	Maynard, Mass.
72	Unisys	18.9%	9,712.9	578.0	12/87	Detroit, Mich.
73	Logicon	18.9%	204.8	6.1	3/87	Torrance, Calif.
74	AEL Industries	18.8%	108.4	3.3	2/87	Landsdale, Pa.
75	Recognition Equipment	18.7%	264.7	11.2	10/87	Dallas, Texas
76	Molex	18.5%	386.8	43.4	6/87	Lisle, Ill.
77	Applied Magnetics	18.0%	211.9	14.2	9/87	Goleta, Calif.
78	AVX	17.7%	271.9	15.8	12/87	Great Neck, N.Y.
79	Pioneer-Standard Electronics	17.5%	212.2	1.8	3/87	Cleveland, Ohio
80	Prime Computer	17.1%	960.9	64.8	12/87	Natick, Mass.
81	Teradyne	16.5%	377.7	-21.1	12/87	Boston, Mass.
82	Analog Devices	16.3%	370.4	18.7	10/87	Norwood, Mass.
83	Intel	16.2%	1,907.1	248.1	12/87	Santa Clara, Calif.
84	Siliconix	15.3%	122.5	3.9	12/87	Santa Clara, Calif.
85	Cohorent	14.6%	159.0	-1.1	9/87	Palo Alto, Calif.
86	Hadco	14.6%	124.3	2.6	10/87	Salem, N.H.
87	Gerber Scientific	14.2%	223.9	21.1	4/87	South Windsor, Conn.
88	Hewlett-Packard	14.1%	8,090.0	644.0	10/87	Palo Alto, Calif.
89	Measurex	14.0%	227.4	26.8	11/87	Cupertino, Calif.
90	Applied Materials	13.9%	174.4	0.3	10/87	Santa Clara, Calif.
91	Varo	13.9%	95.3	3.5	4/87	Garland, Texas
92	Zenith Electronics	13.8%	2,362.7	-19.1	12/87	Glenview, Ill.
93	Printnix	13.8%	123.7	-4.9	3/87	Irvine, Calif.
94	Tandy	13.5%	3,452.2	242.3	6/87	Fort Worth, Texas
95	Wyle Laboratories	13.4%	368.0	5.8	1/88	El Segundo, Calif.
96	Computer Consoles	13.4%	148.4	9.6	12/87	Waltham, Mass.
97	Nicolet Instruments	13.3%	121.6	5.4	3/87	Madison, Wis.
98	AMP	13.3%	2,318.0	250.0	12/87	Harrisburg, Pa.
99	Cherry	12.3%	160.6	2.7	2/87	Waukegan, Ill.
100	Motorola	12.1%	6,700.0	308.0	12/87	Schaumburg, Ill.

Source: ELECTRONIC BUSINESS

The top R&D spenders in the electronics industry

R&D spending was up last year for the third straight year, as companies continue to accelerate their technology investments

Led by the software, capital equipment and minicomputer sectors, 100 of the top U.S. electronics firms pumped 8.6% of their sales revenue into research and development during 1987. Cullinet Software Inc. paced the pack, devoting more than a quarter (28.5%) of its \$174.9 million in revenue to R&D. Last year's leader, Advanced Micro Devices Inc., dropped to second place, with 24.9% of its \$997.1 million in sales so committed.

Actual R&D expenditures at the 100 companies jumped from \$13.0 billion in 1986 to \$15.8 billion last year, a whopping 21.5% increase. This leap came despite a more modest 12.6% growth in sales, which climbed from \$162.1 billion to \$182.5 billion over the same period.

Driving the industry's continuing commitment to R&D have been a combination of factors, including foreign competition, increasing technological complexity and short product life cycles. "The rate of creation of new products is very high in the electronics industry," notes Todd Hixon, vice president of the Boston Consulting Group. "As a result, these companies have to spend continuously on research and development."

This analysis is seconded by Austin Mayer, director of investor relations at Sun Microsystems Inc., which ranked 14th in percentage of revenue devoted to R&D. "Our products typically have an 18 to 24 month life cycle, which means that we're constantly replacing our line," Mayer says. "We always have several generations of products under development simultaneously, which takes a lot of money and effort."

As a subset of the overall economy, electronics far surpasses most other industry sectors in its percentage of revenue spent on R&D. U.S. compa-

BY DWIGHT B. DAVIS
and LINDA STALLMANN

nies overall devoted only 3.4% of their 1987 sales revenue to R&D, according to *Business Week* magazine, or less than half the percentage of the electronics firms.

"The pure play electronics companies such as the big CPU vendors and the semiconductor firms are very committed to research and development," says analyst Hixon. "Many of the big industrial companies, on the other hand — even firms such as General Electric, that have electronics divisions — have come to the conclusion that it's better to take advantage of horizontal mergers with other companies than to invest a lot in R&D." (To qualify for the ELECTRONIC BUSINESS R&D ranking, companies must derive at least 70% of

their revenue from electronics-related sales and be included in the ELECTRONIC BUSINESS 200.)

Still, 1987 shortfalls in sales accounted for at least some of the high percentage of revenue spent at the top-ranked firms. Once R&D budgets are set and projects begun, it can be difficult to cut them back quickly, even if anticipated revenue doesn't materialize. Year-end figures may then reflect unexpectedly high percentages of revenue devoted to R&D.

AMD, for example, had planned to cut its 1987 R&D spending to about 20% of revenue, but softer than expected sales kept the percentage in the mid-20s. For 1988, however, the company is on track in its attempt to hold such spending at 20% of revenue, having cut back on some programs, such as SRAM development, and eliminated other projects entirely.

Even so, 20% spending represents far more than the industry norm, even within the relatively high-spending semiconductor sector, which devoted 9.5% of its 1987 sales to R&D. "Semiconductor companies are pursuing a technology that is not yet close to its limits," explains Hixon.

Foreign competition also plays an important role in this sector, according to AMD chairman and CEO W. Jerry Sanders III. "The U.S. microelectronics industry is in a crucial struggle to retain parity in semiconductor manufacturing with foreign competitors," he said recently, when announcing plans for a new manufacturing facility. "State-of-the-art research and development facilities are essential as the semiconductor industry moves rapidly into the submicron era."

In addition, U.S. chip makers have been forced into large R&D outlays as the lower ends of their product lines have achieved commodity



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status, according to Hixon. "As the Asian companies continue to take share in the commodity end of the market, the U.S. firms must look for advances in application-specific and other high-end products."

Nevertheless, at least two factors have worked to keep semiconductor R&D spending under control. The industry's average R&D expenditures dropped from 10.6% in 1986 to 9.5% last year, in part because industry-wide sales were extremely strong in 1987, despite softness in some industry segments. The monies earmarked for R&D last year therefore ended up accounting for a smaller percentage of overall revenue.

This trend may continue in 1988, says Bob Reed, chief financial officer at 12th-ranked Intel Corp. "We're having another good year," he says, "so it's possible that the percentage of revenue spent on R&D may drop, even though we will show a healthy increase in absolute spending." Intel will spend at least \$300 million this year on R&D, Reed predicts, up from \$260 million last year. "The key is to keep absolute spending growing at a steady pace," he maintains.

The second factor working to ease R&D costs in the semiconductor sector is the proliferation of design automation systems and other productivity tools, according to Reed. Such products "have been a phenomenal help in holding down costs," he says. Without the consequent boost in research productivity, Reed estimates

that Intel would have spent \$350 million to \$400 million on R&D last year, not \$260 million, to achieve the same results.

Closely linked to the semiconductor sector are the capital equipment companies, many of which produce the machines and processes used to fabricate and test memory and microprocessor chips. These firms spent an average of 11.2% of revenue on R&D in 1987, placing them second only to the high-spending software

R&D spending at top electronics companies increased 21.5% despite a more modest 12.6% growth in sales

segment. Applied Materials Inc., ranked at No. 4, spent well above the capital equipment industry average last year, with 17.9% of its revenue going toward R&D, but chairman and CEO James C. Morgan expects his company to approach the sector norm in coming years.

"During the industry downturn we spent very heavily on new products in the etcher, ion implant, epitaxy and CVD [chemical vapor deposition] areas," he explains. "We're now spending on technology at a run rate of about \$40 million a year, and in

actual dollars we expect to spend more every year. But as a percentage of sales, we expect R&D to decline to about 10% to 12%, assuming we're spending \$35 million or more in absolute dollars. The nature of our business is such that if you spend something in that order of magnitude you can get a lot accomplished."

Of Applied Materials' 1,700 worldwide employees, over 200 are directly involved in research and development, Morgan says. A corporate committee of key technology executives is responsible for reviewing product development, although Morgan ultimately oversees all technology projects. "We have about three pages of things I'd like to get to," he says, "and we review the list every six months." Morgan also notes that the company works closely with its customers, "so we can leverage our R&D in that way."

However, neither the semiconductor sector nor the capital equipment companies can match the software industry when it comes to percentage of sales spent on R&D. Software firms spent a whopping 12.4% of their 1987 revenue on R&D, up from 10.1% in 1986. Some of this rise came at the expense of earnings at some of the software companies.

First-ranked Cullinet, for example, suffered a loss of \$27.6 million in 1987, caused in part by the company's large commitment to R&D spending. Cullinet devoted \$50 million to R&D in 1987, up from \$35.5

Leaders in R&D spending

Total 1987 R&D expenditures (\$ millions)

1 IBM	\$5,434.0
2 Digital Equipment	1,010.4
3 Hewlett-Packard	901.0
4 Xerox	722.0
5 Unisys	597.0
6 Motorola	524.0
7 Texas Instruments	428.0
8 GM Hughes Electronics	416.0
9 Control Data	389.0
10 NCR	356.6
11 Honeywell	289.8
12 Intel	259.8
13 Advanced Micro Devices	247.8
14 National Semiconductor	218.9
15 Wang Laboratories	212.4

1987 R&D expenditures per employee

1 Apple Computer	\$34,206
2 Lotus Development	27,819
3 Cray Research	25,262
4 Amdahl	23,545
5 VLSI Technology	22,698
6 Ashton-Tate	22,388
7 Applied Materials	22,193
8 Microsoft	20,967
9 Cullinet Software	20,723
10 Mentor Graphics	20,149
11 LTX	19,919
12 Digital Communications	17,775
13 Altos Computer Systems	17,646
14 3Com	16,837
15 Sun Microsystems	16,637

1987 R&D expenditures as a percentage of revenue

1 Cullinet Software	28.5%
2 Advanced Micro Devices	24.9%
3 LTX	19.2%
4 Applied Materials	17.9%
5 VLSI Technology	17.8%
6 Teradyne	16.3%
7 Cray Research	15.8%
8 Analog Devices	15.1%
9 Lotus Development	14.8%
10 Tektronix	14.3%
11 Computer Consoles	14.0%
12 Intel	13.6%
13 GenRad	13.6%
14 DSC Communications	13.1%
15 Computer Associates	13.0%

Fiscal 1987 figures

Source: ELECTRONIC BUSINESS

million the previous year. "The increase was done by intent, even though we knew it would depress our earnings," says Jeff Papous, vice president for corporate marketing.

Cullinet needed to commit additional funds to R&D, Papous explains, because the company had acquired several companies in an attempt to broaden its product line beyond the IBM mainframe marketplace. "The acquisitions accelerated our time to market," he says, "but we needed to beef up our internal R&D to make all of the new products compatible with one another and with our existing line."

Papous says Cullinet is also spending heavily in R&D because of the firm's efforts to develop applications software to supplement its traditional systems software products. Nevertheless, the company's percentage of R&D spending will drop to about 19% of revenue this year, and should hold steady at that level, he says.

Although Cullinet experienced unique pressures in 1987 that pushed its R&D spending percentage above all other electronics companies, several shared aspects of the software industry worked to keep the sector as a whole at the top of the R&D list. "In a way, software companies are almost pure product development businesses," says analyst Hixon. "Their raw materials and manufacturing costs are negligible compared to other industry sectors, and the percentage of money spent on R&D is subsequently higher."

The company profile at ninth-ranked Lotus Development Corp. supports this perspective, given that approximately one-third of the firm's employees have some R&D association, according to Ed Belove, vice president for corporate R&D. But an unrelated factor is probably responsible for the software sector's 2.3% jump in spending from 1986 to 1987, he believes.

Platform proliferation

"From 1981 to 1986, many of us in the software industry had a single platform on which to build our products: the IBM PC and its compatibles," Belove notes. "Around 1986, however, all sorts of new platforms appeared, including OS/2 and Presentation Manager-based machines, Unix workstations, the Macintosh and, for us, mainframes. During

Companies with the fastest growth in R&D spending

R&D expenditures	Percentage growth from 1986	Total 1987 (\$ millions)
Genicom	143.3%	\$14.9
MiniScribe	131.7%	19.8
Sun Microsystems	127.0%	69.6
Maxtor	98.3%	11.8
Micropolis	94.5%	21.8
3Com	86.7%	9.3
Microsoft	85.5%	38.1
Lotus Development	79.6%	58.4
Compaq Computer	77.1%	47.1
Intelligent Systems	70.2%	6.5
BBN	65.4%	14.3
Computer Associates	58.1%	40.1
Wyse Technology	55.6%	13.9
Western Digital	51.6%	37.4
Amdahl	50.2%	178.9

Source: ELECTRONIC BUSINESS

1987, we undertook a lot of efforts to develop products for these different platforms, and our expenses, subsequently, were high."

Lotus' 14.8% R&D spending in 1987 was "probably a bit high for us," says Belove. The company doesn't set specific spending goals for R&D as a percentage of revenue, but Belove believes 10% would be closer to the desirable level. Still, he expects that this year's spending may continue at an elevated rate, in part because customers want compatibility

Software firms don't yet have the productivity tools to keep costs down

among all the different types of machines now installed. Achieving such compatibility will require continued heavy R&D investments, Belove predicts.

In addition, software companies don't yet have the productivity tools that have helped the semiconductor industry hold its costs down, points out Martyn Roetter, manager of the information and telecommunications industry practice at Arthur D. Little. "CASE [computer-aided software engineering] tools have not yet fulfilled their promise," he says. "As a result,

software development is still very people-intensive."

Other electronics industry sectors, such as the peripherals, communications, components and government groups, fall below the 8.6% industry spending average, but even the lowest ranked (5.4%) government sector surpasses the 3.4% average of all U.S. businesses. The reasons why these sectors trail others in the electronics industry are varied. In the case of the defense-dependent government sector, for example, reductions in DOD expenditures have kept R&D spending down.

In other cases, subcategories of companies within sectors have bucked their sectors' overall trends. One example is that of disk drive companies within the peripherals sector. Three of the top five companies ranked by the percentage increase in revenue spent on R&D from 1986 to 1987 were disk drive manufacturers.

This jump reflects the "law of diminishing returns" in this sector, says Robert Katzive, vice president of Disk/Trend Inc. "You can spend the same amount and be late in the marketplace, or you can spend more and keep up," the market researcher says. "And this industry isn't kind to latecomers."

Technological factors have also put pressure on disk drive companies to increase sales, Katzive says, with low-end vendors shifting to the small format 3.5-inch drives and high-end suppliers packing more capacity into their products. "Drives in the 380-megabyte and above range are not easy to design [or manufacture]," he notes.

In the future, it can be expected that electronics companies of all types will continue to outpace other industry sectors in R&D outlays.

"Looking at the total R&D expenditure is too crude a measure," Roetter says. "How much is spent on basic research? How much on design engineering? How much on product engineering?" he asks.

Noting the success that Japanese firms have achieved by concentrating resources on manufacturing engineering, Roetter believes that U.S. firms need to follow suit. "It makes no sense to spend lots of money developing advanced new products if there's no way to economically manufacture them," he concludes.

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Top R&D spenders

1987 R&D rank	Company	R&D as a percentage of revenue	Total R&D expenditures (\$ millions)	Percentage change in expenditures from 1986	Fiscal 1987 revenue (\$ millions)	Percentage change in revenue from 1986	Fiscal 1987 net income (\$ millions)	Percentage change in net income from 1986	Fiscal year ended
1	Cullinet	28.5%	\$49.9	40.4%	\$174.9	-7.6%	-\$27.6	NM	4/87
2	Advanced Micro Devices	24.9%	247.8	34.8%	997.1	73.1%	-48.1	NM	12/87
3	LTX	19.2%	23.2	7.5%	120.6	26.4%	-6.7	NM	7/87
4	Applied Materials	17.9%	31.2	26.7%	174.4	16.9%	0.3	-72.9%	10/87
5	VLSI Technology	17.8%	30.5	31.0%	172.0	54.0%	8.1	14,294.6%	12/87
6	Teradyne	16.3%	61.5	21.1%	377.7	23.4%	-21.5	NM	12/87
7	Cray Research	15.8%	108.8	24.1%	687.3	15.2%	147.1	17.8%	12/87
8	Analog Devices	15.1%	56.0	23.8%	370.4	10.8%	18.7	-20.2%	10/87
9	Lotus Development	14.8%	58.4	79.6%	395.6	39.9%	72.0	49.2%	12/87
10	Tektronix	14.3%	199.6	0.7%	1,395.9	2.8%	51.2	30.2%	5/87
11	Computer Consoles	14.0%	20.8	-13.3%	148.4	14.5%	9.6	NM	12/87
12	Intel	13.6%	259.8	13.8%	1,907.1	50.8%	175.5	NM	12/87
13	GenRad	13.6%	26.4	-26.6%	193.8	-5.2%	2.1	NM	12/87
14	DSC Communications	13.1%	40.9	-11.5%	312.4	2.8%	14.6	31.9%	12/87
15	Computer Associates	13.0%	40.1	58.1%	309.3	61.9%	36.5	96.9%	3/87
16	Sun Microsystems	12.9%	69.6	127.0%	537.5	155.8%	36.3	203.8%	6/87
17	General DataComm	12.6%	25.3	29.2%	200.6	12.7%	0.8	-80.1%	9/87
18	Data General	12.5%	159.4	11.4%	1,274.3	0.5%	-82.9	NM	9/87
19	Avantek	12.3%	26.3	3.5%	213.7	2.6%	11.6	-28.0%	12/87
20	Amdahl	11.9%	178.9	50.2%	1,505.2	55.8%	142.0	261.0%	12/87
21	National Semiconductor	11.7%	218.9	-1.6%	1,867.9	26.4%	-28.8	NM	5/87
22	Digital Communications	11.6%	21.1	35.3%	181.4	31.6%	27.0	31.2%	6/87
23	Control Data	11.6%	389.0	23.9%	3,366.5	0.6%	25.0	NM	12/87
24	Prime Computer	11.4%	109.7	19.3%	960.9	11.7%	64.8	38.0%	12/87
25	Micom Systems	11.3%	22.3	40.2%	196.7	3.8%	12.2	13.2%	3/87
26	Coherent	11.3%	18.0	21.4%	159.0	15.1%	-1.1	NM	9/87
27	Cipher Data Products	11.3%	20.1	33.3%	178.2	9.3%	4.3	-39.8%	6/87
28	Hewlett-Packard	11.1%	901.0	9.3%	8,090.0	13.9%	644.0	24.8%	10/87
29	Apollo Computer	11.0%	61.1	36.9%	553.7	41.4%	21.7	132.5%	12/87
30	LSI Logic	11.0%	28.9	34.1%	262.1	34.9%	10.7	178.8%	12/87
31	Microsoft	11.0%	38.1	85.5%	345.9	75.1%	71.9	83.1%	6/87
32	Mentor Graphics	10.9%	24.2	43.9%	221.8	27.8%	20.3	84.8%	12/87
33	Fluke	10.8%	22.2	-7.8%	206.3	-1.3%	2.0	-83.5%	9/87
34	Digital Equipment	10.8%	1,010.4	24.1%	9,389.4	23.7%	1,137.4	84.2%	6/87
35	Intergraph	10.5%	67.5	16.9%	641.1	5.8%	69.9	-0.7%	12/87
36	Perkin-Elmer	10.5%	140.2	33.5%	1,333.6	3.3%	-18.2	NM	7/87
37	Tandem Computers	10.5%	108.5	25.2%	1,035.5	34.9%	105.6	65.6%	9/87
38	Ashton-Tate	10.5%	28.0	43.5%	267.3	26.8%	43.1	43.1%	1/88
39	Stratus Computer	10.3%	18.9	34.0%	184.2	47.8%	19.4	43.5%	12/87
40	Gould	10.1%	94.3	-3.7%	933.4	2.7%	25.0	-27.7%	12/87
41	IBM	10.0%	5,434.0	36.7%	54,217.0	5.8%	5,258.0	9.8%	12/87
42	Westmark International	9.6%	28.0	17.9%	291.9	19.8%	-7.2	NM	12/87
43	Quantum	9.5%	11.5	1.8%	120.8	-0.4%	8.8	-60.4%	3/87
44	ADC Telecommunications	9.3%	15.5	19.2%	166.9	16.1%	15.3	27.5%	10/87
45	Applied Magnetics	9.2%	19.5	14.9%	211.9	65.4%	14.2	246.6%	9/87
46	Dynatech	9.0%	27.3	23.7%	304.7	18.7%	23.2	13.5%	3/87
47	Altos Computer Systems	9.0%	13.8	27.9%	153.9	14.7%	9.7	-52.3%	6/87
48	AMP	8.8%	204.0	20.0%	2,317.8	19.9%	249.7	51.9%	12/87
49	TIE/communications	8.6%	21.4	-6.2%	250.2	-16.1%	-11.1	NM	12/87
50	3Com	8.4%	9.3	86.7%	110.4	72.5%	11.1	66.8%	5/87

NM = Not meaningful. The company lost money in the base year

(Continued)

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Top R&D spenders

1987 R&D rank	Company	R&D as a percentage of revenue	Total R&D expenditures (\$ millions)	Percentage change in expenditures from 1986	Fiscal 1987 revenue (\$ millions)	Percentage change in revenue from 1986	Fiscal 1987 net income (\$ millions)	Percentage change in net income from 1986	Fiscal year ended
51	Medtronic	8.4%	\$42.1	9.3%	\$502.0	24.6%	\$73.8	9.5%	4/87
52	ISC Systems	8.4%	14.1	-5.2%	168.5	1.5%	6.5	-52.9%	6/87
53	Varian Associates	8.2%	80.7	-1.9%	982.8	10.3%	21.4	NM	9/87
54	Paradyne	8.2%	19.0	-2.4%	232.6	-10.9%	-2.6	NM	12/87
55	Western Digital	8.1%	37.4	51.6%	462.5	65.5%	42.8	99.2%	6/87
56	Storage Technology	8.0%	60.1	-3.3%	750.0	7.8%	19.0	12.8%	12/87
57	Motorola	7.8%	524.0	6.5%	6,707.0	13.9%	308.0	58.8%	12/87
58	Texas Instruments	7.7%	428.0	5.4%	5,594.5	12.5%	256.9	543.9%	12/87
59	Micropolis	7.5%	21.8	94.5%	288.3	35.2%	27.2	49.3%	12/87
60	Wang Laboratories	7.5%	212.4	4.7%	2,836.7	7.3%	70.7	38.9%	6/87
61	Gerber Scientific	7.4%	16.6	-7.2%	223.9	16.7%	21.1	15.8%	4/87
62	Measurex	7.3%	16.7	18.3%	227.4	18.0%	26.8	27.3%	11/87
63	Apple Computer	7.2%	191.6	49.9%	2,661.1	39.9%	217.5	451.7%	9/87
64	Xerox	7.0%	722.0	11.1%	10,320.0	10.3%	578.0	18.4%	12/87
65	Diasonics	6.9%	18.5	35.4%	267.6	23.2%	15.2	NM	12/87
66	Aydin	6.7%	10.0	32.4%	149.2	9.1%	8.8	26.6%	12/87
67	Maxtor	6.7%	11.8	98.3%	175.3	105.9%	22.4	109.5%	3/87
68	Dataproducts	6.6%	22.4	-27.9%	338.8	-4.3%	9.0	NM	3/87
69	Watkins-Johnson	6.4%	16.9	4.2%	264.3	3.5%	17.1	-0.7%	12/87
70	NCR	6.3%	356.6	11.2%	5,640.7	15.5%	419.3	24.6%	12/87
71	Veeco Instruments	6.2%	12.2	-1.4%	195.6	16.6%	9.2	2,328.2%	9/87
72	Datapoint	6.2%	19.4	-14.4%	312.1	-4.0%	-58.5	NM	7/87
73	Unisys	6.1%	597.0	35.4%	9,712.9	30.7%	578.0	NM	12/87
74	Bolt Beranek and Newman	6.1%	14.3	65.4%	233.8	31.3%	-8.0	NM	6/87
75	Oracle Systems	6.0%	7.9	12.9%	131.3	137.0%	15.6	165.0%	5/87
76	Cherry Electrical Products	6.0%	9.6	11.1%	160.6	24.2%	2.7	NM	2/87
77	Harris	5.7%	118.0	0.1%	2,079.0	-6.2%	84.5	41.8%	6/87
78	Decision Industries ¹	5.7%	10.9	6.4%	191.4	-1.9%	-20.4	NM	11/87
79	M/A-COM	5.6%	24.5	-28.0%	436.1	-24.5%	-29.3	NM	9/87
80	Molex	5.5%	21.2	23.6%	386.8	32.5%	43.4	35.5%	6/87
81	MiniScribe	5.5%	19.8	131.7%	362.5	96.0%	28.1	38.8%	12/87
82	AST Research	5.4%	11.1	32.1%	206.0	19.5%	13.0	-52.0%	6/87
83	Wyse Technology	5.3%	13.9	55.6%	260.0	56.2%	18.1	44.1%	3/87
84	International Rectifier	5.3%	8.1	-12.5%	151.8	4.6%	-17.2	NM	6/87
85	Augat	5.1%	16.1	-3.6%	313.2	20.4%	11.5	NM	12/87
86	Genicom	4.9%	14.9	143.3%	302.2	91.9%	12.6	45.9%	12/87
87	Sprague Technologies	4.8%	20.8	-6.7%	437.3	-2.6%	3.6	NM	12/87
88	Litton Industries	4.7%	209.7	-18.3%	4,419.7	-2.2%	138.1	94.3%	7/87
89	Kollmorgen	4.7%	14.2	-14.6%	301.0	-5.7%	0.3	NM	12/87
90	Andrew	4.7%	10.4	-21.7%	223.2	12.9%	3.8	-59.9%	9/87
91	Esterline	4.7%	12.1	6.1%	259.7	10.1%	-29.3	NM	10/87
92	Loral	4.6%	32.0	3.3%	690.0	4.0%	57.5	8.4%	3/87
93	Recognition Equipment	4.4%	11.6	0.3%	264.7	9.5%	11.2	6.4%	10/87
94	Zenith Electronics	4.4%	103.4	3.7%	2,362.7	24.9%	-19.1	NM	12/87
95	Honeywell	4.3%	289.8	17.5%	6,679.3	24.2%	253.7	1,866.7%	12/87
96	Scientific-Atlanta	4.1%	20.1	-27.1%	495.3	5.6%	24.2	NM	6/87
97	MAI Basic Four	4.0%	12.9	-16.0%	321.0	14.2%	22.8	34.9%	9/87
98	Intelligent Systems	4.0%	6.5	70.2%	163.2	30.0%	10.2	540.6%	12/87
99	GM Hughes Electronics	4.0%	416.0	1.9%	10,481.0	0.4%	521.1	17.1%	12/87
100	Compaq Computer	3.8%	47.1	77.1%	1,224.1	95.8%	136.3	217.7%	12/87

NM = Not meaningful. The company lost money in the base year

¹ Decision Industries went private April 29, 1988

Source: ELECTRONIC BUSINESS

STRATEGIES

MANAGING TECHNOLOGY

Top R&D spenders by industry segment

Fiscal 1987 figures

	Total R&D expenditures (\$ millions)	R&D as a percentage of revenue	R&D expenditures per employee
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Minicomputers

IBM	\$5,434.0	10.0%	\$13,957
Digital Equipment	\$1,010.4	10.8%	\$9,144
Hewlett-Packard	\$901.0	11.1%	\$10,988
Data General	\$159.4	12.5%	\$10,163
Prime Computer	\$109.7	11.4%	\$12,439
Tandem Computers	\$108.5	10.5%	\$15,481
Gould	\$94.3	10.1%	\$9,313
Sun Microsystems	\$69.6	12.9%	\$16,637
Apollo Computer	\$61.1	11.0%	\$15,285
Computer Consoles	\$20.8	14.0%	\$16,144
Stratus Computer	\$18.9	10.3%	\$15,449
MAI Basic Four	\$12.9	4.0%	\$3,960
Segment total	\$8,000.7		
Segment averages		10.3%	\$12,551

Mainframes

IBM	\$5,434.0	10.0%	\$13,957
Unisys	\$597.0	6.1%	\$6,454
Control Data	\$389.0	11.6%	\$11,275
NCR	\$356.6	6.3%	\$5,752
Amdahl	\$178.9	11.9%	\$23,545
Cray Research	\$108.8	15.8%	\$25,262
Segment total	\$7,064.4		
Segment averages		9.4%	\$11,968

Office equipment

IBM	\$5,434.0	10.0%	\$13,957
Xerox	\$722.0	7.0%	\$7,293
NCR	\$356.6	6.3%	\$5,752
Wang Laboratories	\$212.4	7.5%	\$7,009
Harris	\$118.0	5.7%	\$4,856
Pitney Bowes	\$65.1	2.9%	\$2,210
Datapoint	\$19.4	6.2%	\$7,046
Diebold	\$14.3	3.3%	\$2,938
Savin	\$4.6	1.3%	\$2,272
Segment total	\$6,946.4		
Segment averages		8.9%	\$10,785

Microcomputers

IBM	\$5,434.0	10.0%	\$13,957
Apple Computer	\$191.6	7.2%	\$34,206
Zenith Electronics	\$103.4	4.4%	\$2,954
Compaq Computer	\$47.1	3.8%	\$11,776
Atari	\$18.0	3.7%	\$4,412
Altos Computer	\$13.8	9.0%	\$17,646
AST Research	\$11.1	5.4%	\$8,186
Tandon	\$10.3	3.6%	\$2,938
Segment total	\$5,829.3		
Segment averages		9.5%	\$13,138

	Total R&D expenditures (\$ millions)	R&D as a percentage of revenue	R&D expenditures per employee
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Government

Motorola	\$524.0	7.8%	\$5,363
Texas Instruments	\$428.0	7.7%	\$5,488
GM Hughes Electronics	\$416.0	4.0%	\$4,160
Honeywell	\$289.8	4.3%	\$3,674
Litton Industries	\$209.7	4.7%	\$3,869
Harris	\$118.0	5.7%	\$4,856
Gould	\$94.3	10.1%	\$9,313
Varian Associates	\$80.7	8.2%	\$6,784
Singer	\$38.4	2.0%	\$1,371
E-Systems	\$33.7	2.7%	\$2,173
Loral	\$32.0	4.6%	\$2,203
Watkins-Johnson	\$16.9	6.4%	\$5,414
Aydin	\$10.0	6.7%	\$5,023
Cubic	\$5.2	1.4%	\$1,164
Logicon	\$1.6	0.8%	\$643
Segment total	\$2,298.4		
Segment averages		5.4%	\$4,376

Semiconductors

Motorola	\$524.0	7.8%	\$5,363
Texas Instruments	\$428.0	7.7%	\$5,488
Intel	\$259.8	13.6%	\$13,531
Advanced Micro Devices	\$247.8	24.9%	\$13,755
National Semiconductor	\$218.9	11.7%	\$7,497
Harris	\$118.0	5.7%	\$4,856
Gould	\$94.3	10.1%	\$9,313
Analog Devices	\$56.0	15.1%	\$10,777
Western Digital	\$37.4	8.1%	\$11,204
VLSI Technology	\$30.5	17.8%	\$22,698
LSI Logic	\$28.9	11.0%	\$12,465
International Rectifier	\$8.1	5.3%	\$3,429
Segment total	\$2,051.7		
Segment averages		9.5%	\$7,049

Capital equipment

Hewlett-Packard	\$901.0	11.1%	\$10,988
Tektronix	\$199.6	14.3%	\$11,676
Perkin-Elmer	\$140.2	10.5%	\$9,929
Varian Associates	\$80.7	8.2%	\$6,784
Teradyne	\$61.5	16.3%	\$13,089
Applied Materials	\$31.2	17.9%	\$22,193
GenRad	\$26.4	13.6%	\$12,484
LTX	\$23.2	19.2%	\$19,919
John Fluke	\$22.2	10.8%	\$9,258
Gerber Scientific	\$16.6	7.4%	\$9,229
Esterline	\$12.1	4.7%	\$3,834
Sun Electric	\$5.0	2.4%	\$2,035
Segment total	\$1,519.7		
Segment averages		11.2%	\$10,532

(Continued)

STRATEGIES

MANAGING TECHNOLOGY

Top R&D spenders by industry segment

Fiscal 1987 figures	Total R&D expenditures (\$ millions)	R&D as a percentage of revenue	R&D expenditures per employee	Total R&D expenditures (\$ millions)	R&D as a percentage of revenue	R&D expenditures per employee	
Computer-based systems				Peripherals (continued)			
Hewlett-Packard	\$901.0	11.1%	\$10,988	Xidex	\$11.6	2.0%	\$1,679
Honeywell	\$289.8	4.3%	\$3,674	Quantum	\$11.5	9.5%	\$16,522
Intergraph	\$67.5	10.5%	\$10,710	Decision Industries	\$10.9	5.7%	\$7,027
Coherent	\$18.0	11.3%	\$11,106	Tandon	\$10.3	3.6%	\$2,938
Measurex	\$16.7	7.3%	\$6,578	Intelligent Systems	\$6.5	4.0%	\$13,235
Gerber Scientific	\$16.6	7.4%	\$9,229	Segment total	\$688.6	—	—
ISC Systems	\$14.1	8.4%	\$7,898	Segment averages	—	7.9%	\$6,786
Recognition Equipment	\$11.6	4.4%	\$3,990				
Sun Electric	\$5.0	2.4%	\$2,035				
Segment total	\$1,340.3	—	—				
Segment averages	—	8.0%	\$7,434				
Communications				Components			
Motorola	\$524.0	7.8%	\$5,363	AMP	\$204.0	8.8%	\$9,273
DSC Communications	\$40.9	13.1%	\$16,076	Molex	\$21.2	5.5%	\$4,264
Dynatech	\$27.3	9.0%	\$8,818	Sprague Technologies	\$20.8	4.8%	\$2,414
Avantek	\$26.3	12.3%	\$8,651	Augat	\$16.1	5.1%	\$4,237
General DataComm	\$25.3	12.6%	\$9,574	Cherry Electrical	\$9.6	6.0%	\$3,333
General Instrument	\$24.7	3.1%	\$1,517	AVX	\$8.4	3.1%	\$1,120
M/A-COM	\$24.5	5.6%	\$3,624	CTS	\$5.3	2.0%	\$798
Micom Systems	\$22.3	11.3%	\$10,924	BRIntec	\$4.5	1.5%	\$1,152
TIE/communications	\$21.4	8.6%	\$14,298	Oak Industries	\$4.0	2.2%	\$1,046
Digital Communications	\$21.1	11.6%	\$17,775	Segment total	\$293.9	—	—
Scientific-Atlanta	\$20.1	4.1%	\$5,999	Segment averages	—	6.4%	\$4,581
Paradyne	\$19.0	8.2%	\$6,095				
ADC Telecommunications	\$15.5	9.3%	\$8,615				
Bolt Beranek and Newman	\$14.3	6.1%	\$5,352				
Andrew	\$10.4	4.7%	\$4,528				
Aydin	\$10.0	6.7%	\$5,023				
3Com	\$9.3	8.4%	\$16,837				
Dynascan	\$1.6	0.8%	\$4,145				
Segment total	\$858.0	—	—				
Segment averages	—	7.5%	\$5,609				
Peripherals				Software			
Control Data	\$389.0	11.6%	\$11,275	Lotus Development	\$58.4	14.8%	\$27,819
Storage Technology	\$60.1	8.0%	\$6,776	Cullinet Software	\$49.9	28.5%	\$20,723
Seagate Technology	\$33.6	3.5%	\$2,097	Computer Associates	\$40.1	13.0%	\$14,853
Dataproducts	\$22.4	6.6%	\$5,731	Microsoft	\$38.1	11.0%	\$20,967
Micropolis	\$21.8	7.5%	\$9,124	Ashton-Tate	\$28.0	10.5%	\$22,388
Cipher Data Products	\$20.1	11.3%	\$10,683	Mentor Graphics	\$24.2	10.9%	\$20,149
MiniScribe	\$19.8	5.5%	\$3,988	Oracle Systems	\$7.9	6.0%	\$7,026
Applied Magnetics	\$19.5	9.2%	\$2,807	Ultimate	\$4.5	2.6%	\$10,000
Genicom	\$14.9	4.9%	\$4,163	Segment total	\$251.1	—	—
Wyse Technology	\$13.9	5.3%	\$6,863	Segment averages	—	12.4%	\$19,244
Maxtor	\$11.8	6.7%	\$6,109				
				Medical			
				Medtronic	\$42.1	8.4%	\$8,504
				Westmark International	\$28.0	9.6%	\$9,267
				Diasonics	\$18.5	6.9%	\$12,243
				Segment total	\$88.6	—	—
				Segment averages	—	8.3%	\$9,342

Segment R&D as a percentage of revenue averages are weighted

Continued next column

Segment R&D as a percentage of revenue averages are weighted

Source: ELECTRONIC BUSINESS

Power pay: How the big guys made even more money

The 100 highest-paid electronics executives had to put up with a 23% raise last year. Their average take-home? Just \$780,000

Most of us fret about how we're going to make ends meet on our inflation-pacing salary increments. But not the top executives in the U.S. electronics industry. The 100 highest-paid are plagued instead by the nightmare of how to spend their 23% raise.

According to a new survey by ELECTRONIC BUSINESS, the average paycheck for the top-paid 100 electronics executives rose \$149,094 in 1987, or 23.5% over the past year, making for an average weekly compensation of \$15,100.

And ELECTRONIC BUSINESS' "million-dollar club" boosted its membership dramatically as the ranks of those bringing home seven-figure compensation rose from six to 17. Disk-drive maker Seagate Technology Inc. claimed the honor of having the most new members initiated into the club, bringing three new names to the list.

The big winners were computer company executives, with over 50% of this year's highest-paid 100 coming from computer, peripherals or software companies. Also, with the exception of Xerox Corp. and Advanced Micro Devices Inc., all the members of the million-dollar club came from this same group.

One of the major reasons for the boost to top executive compensation is the increased profitability of the electronics industry in 1987. The recent ELECTRONIC BUSINESS 200 survey found that sales for the top 200 U.S. electronics companies were up 7.4%, while profitability climbed 53.6% [ELECTRONIC BUSINESS July 15, 1988 p26]. This translates into dollar signs for executives whose salaries and bonuses are normally tied to the performance of the company.

While cash is still king in the world of executive compensation, there are

BY TONY GREENE

other factors that top staffers are beginning to look for. Research by ELECTRONIC BUSINESS reveals several distinct trends:

- Contracts, which have not been prevalent until recently, are becoming more popular. This is believed to be mainly in response to executives' need for a feeling of security in today's volatile mergers-and-acquisitions world.

- As the industry matures, companies are looking for older, more seasoned executives to head companies. But "mature" is a relative term; and senior executives in the electronics industry still tend to be younger than execs in other industries.

The bottom line for the electronics industry's highest-paid execs: Cash is still king

- Perquisites such as company houses and cars, while still nice, are not the incentive they used to be under the new tax laws. Executives and their recruiters are holding their breath to see what the coming year will bring in the area of taxes.

- Executive recruiters see a shortage of qualified upper level executives in the future of the electronics industry — a shortage that will make compensation a critical factor as companies strive to get and keep top level people.

Seagate is one company that should not have to worry about keeping its execs. The disk-drive maker boasts three chiefs in the ELECTRONIC BUSINESS power-pay club — David

T. Mitchell, president and COO; Douglas K. Mahon, senior vice president and chief technical officer; and Alan F. Shugart, chairman of the board and CEO. And it places two other executives in the top 100, putting all five of their top-paid executives on the rolls.

Seagate's top trio experienced an average increase of 209.2% — compensation that came as a direct response to the company's performance in 1986 and 1987. Seagate declined to comment on whether salaries this year would show a corresponding decrease as the company reported a fall in net income of 56% in the fourth quarter of fiscal 1988, ended June 30.

In addition to Seagate, Apple Computer Inc., Compaq Computer Corp. and Unisys Corp. all put five executives in the top 100. John Sculley, Apple's president and CEO, leads this year's list with a modest increase of 26.1% to \$2,140,000. The No. 2 on ELECTRONIC BUSINESS' top-pay list, W. Michael Blumenthal, chairman and CEO of Unisys Corp., is the only person in the top five to show a decrease: 28.8% down from 1986 to give him cash compensation of \$1,549,440.

Honeywell Inc.'s top paid executives — Edson W. Spenser, chairman and CEO; and James J. Renier, president and COO — provide a good example of how executive compensation can be tied to profitability. Both men experienced reductions in their cash compensation in 1986 [ELECTRONIC BUSINESS Oct. 15, 1987 p52] when Honeywell reported a loss of \$389 million. In fact, in 1987, when the company showed net income of \$254 million, Spenser and Renier had an average increase of 88.5%. A spokesperson for Honeywell says that executive compensation is tied to three factors: the company's earn-

ings, return on investment and return on equity.

Executive salaries have risen strongly throughout the electronics industry. A recent survey by the American Electronics Association shows that last year, executive salaries posted their largest average increase — 7.5% — since 1984. This is up more than 2% from the previous year. This is still not as high, though, as the average increase for top executives in all industries. Jill Kanin-Lovers, an associate at Towers, Perrin, Forster and Crosby, a New York City-based consulting firm that specializes in executive compensation, says that according to their survey, senior benchmark salaries rose an average of 12% in 1988.

Sign here, please

Although salaries are going up and business is good, many executives are edgy about their security and are asking for contracts. Alan Glou, president of Needham, Massachusetts-based Glou International Inc., an executive search firm that specializes in the electronics industry, says, "They're looking for security with companies that have the ability to be acquired." What most of the contracts amount to is a guarantee of severance pay — a buy-out clause — if the company is acquired. Chris Blake, president of San Jose executive search firm Robert S. Blake Associates Inc., says, "There is no security in the electronics industry — only opportunity."

Another factor that is going to be figuring into executive compensation is the law of supply and demand. "There is a shortage of seasoned, qualified people at the upper executive level," says James W. Furlong, president of Van Nuys, California-based executive search firm Furlong-Gates. As the industry matures, there



The men with the megabucks: Apple Computer chairman John Sculley, \$2,140,000; Unisys chairman Michael Blumenthal, \$1,549,440; Computer Associates CEO Charles Wang, \$1,431,000; Compaq Computer president Joseph "Rod" Canion, \$1,375,000; and Seagate Technology president David "Tom" Mitchell, \$1,354,975

is a greater need for experienced top level management that will give executives leverage to demand greater cash compensation in the future.

One of the problems is the general feeling — Sculley's crossover from PepsiCo Inc. to Apple notwithstanding — that executives from other industries cannot run electronics concerns. Gene Spence, a partner at the executive search firm Heidrick and Struggles Inc., which placed Sculley at Apple, says, "Sculley is the exception, not the norm."

The bottom line is that cash is still king. Perquisites such as company

houses and cars are not as popular as they once were because they are currently taxed like cash, so senior staffers feel they may as well settle for cash in the first place. But, while cash may be king, stock options are not dead. They are still a major part of any upper-level compensation package. The increase in cash is in addition to, not instead of, stock options. This is even true of executives going to start-ups and venture capital-backed firms. "Gone are the days when executives will take a hit to go to a venture-funded company," says Spence. □

STRATEGIES

EXECUTIVE COMPENSATION

Top paid executives

Rank	Executive/age	1987 salary	Percentage change from previous year	Company	Position
1	John Sculley/48	\$2,140,000	26.1%	Apple Computer	Chairman, president, CEO
2	W. Michael Blumenthal/62	1,549,440	-28.8%	Unisys	Chairman, CEO
3	Charles E. Wang/43	1,431,000	NA	Computer Associates	CEO, chairman
4	Joseph R. Canlon/42	1,375,000	150.0%	Compaq Computer	President, CEO, director
5	David T. Mitchell/45	1,354,975	193.2%	Seagate Technology	President, COO
6	Douglas K. Mahon	1,274,120	210.4%	Seagate Technology	Senior VP, chief technical officer
7	Alan F. Shugart/56	1,263,951	223.9%	Seagate Technology	Chairman, CEO
8	Paul G. Stern/48 ¹	1,195,920	43.4%	Unisys	President
9	John A. Young/55	1,193,300	29.8%	Hewlett-Packard	President, CEO, chairman
10	Anthony W. Wang/45	1,188,000	NA	Computer Associates	President, COO, director
11	David T. Kearns/57	1,165,465	33.2%	Xerox	Chairman, CEO
12	W. J. Sanders III/51	1,057,080	121.6%	Advanced Micro Devices	Chairman, CEO
13	Joseph J. Kroger	1,029,337	NA	Unisys	Vice chairman
14	Fred W. O'Grady/66	1,022,510	NA	Litton Industries	Chairman, director
15	Edson W. Spenser/61	1,014,185	80.5%	Honeywell	Chairman, director
16	Charles E. Exley Jr./58	1,001,200	6.7%	NCR	Chairman, CEO
17	Paul C. Ely Jr./56	1,000,000	-15.9%	Convergent	Chairman
18	Jim P. Manzi/36	940,872	18.4%	Lotus	President, chairman, director
19	John V. Roach/48	916,240	50.5%	Tandy	Chairman, CEO, president
20	Kenneth H. Olsen/61	905,706	20.0%	Digital Equipment	President, CEO
21	Thomas P. Howes ²	901,000	NA	Esterline	President
22	John C. Lewis/52	898,013	8.1%	Amdahl	Chairman, CEO
23	Robert M. Price/57	885,858	7.0%	Control Data	Chairman, president, CEO
24	Melvin Howard/53	875,952	24.5%	Xerox	Vice chairman, subsidiary officer
25	Edward M. Esber, Jr./35	874,086	-7.3%	Ashton Tate	Chairman, CEO
26	James J. Renier/58	861,256	96.5%	Honeywell	President, COO, CEO, director
27	John F. Akers/53	840,896	18.1%	IBM	Chairman
28	David R. Tacke/65	837,319	22.2%	E-Systems	Chairman, CEO
29	Delbert W. Yocum	832,000	69.2%	Apple Computer	Executive VP, COO
30	John F. Cunningham/45	831,664	NA	Computer Consoles	Chairman, president, CEO
31	Jean-Louis Gasse	831,000	148.5%	Apple Computer	VP product development
32	Eckhard Pfeiffer/45	827,965	176.0%	Compaq Computer	Senior VP international
33	Stephen L. Lane/51	827,500	NA	Emerson Radio	President
34	William W. Lane/53	827,500	NA	Emerson Radio	Chairman
35	John T. Hartley/57	819,578	30.0%	Harris	President, CEO
36	Anthony R. Hamiliton/63	814,668	14.3%	Avnet	Chairman, CEO
37	Leon Machiz/63	814,668	14.3%	Avnet	Vice chairman, COO, president
38	William F. Glavin/56	800,014	37.6%	Xerox	Vice chairman
39	Frank G. Hickey/60	797,767	79.8%	General Instrument	Chairman, CEO
40	James A. Unruh/46 ¹	795,961	73.3%	Unisys	Executive VP
41	George B. Harvey/56	794,093	-28.0%	Pitney Bowes	Chairman, president, CEO
42	Orion L. Hoch/58	782,621	NA	Litton Industries	President, CEO, director
43	Donald L. Waite	762,303	191.1%	Seagate Technology	Senior VP, CFO
44	William F. Schmied/59	756,933	28.3%	Singer	President, COO
45	Dean O. Morton/55	750,121	29.6%	Hewlett-Packard	Executive VP, COO, director
46	William J. Weisz/50	746,170	27.1%	Motorola	Vice chairman
47	Joe M. Henson/54	737,857	7.9%	Prime Computer	President, CEO, director
48	Lawrence J. Ellison/43	711,875	NA	Oracle	President
49	Paul A. Allaire/49	709,119	49.3%	Xerox	President
50	Michael H. Spindler	709,000	47.6%	Apple Computer	Senior VP, int'l sales & marketing

¹ resigned Dec. 31, 1987

² resigned

NA = Not available

(Continued)

STRATEGIES

EXECUTIVE COMPENSATION

Top paid executives

Rank	Executive/age	1987 salary	Percentage change from previous year	Company	Position
51	Norbert R. Berg/56	\$707,940	5.2%	Control Data	Deputy chairman
52	Andrew S. Grove/51	697,011	92.5%	Intel	President, COO
53	Bertil D. Nordin/53 ¹	686,077	85.5%	Digital Communications	President, chairman, CEO
54	Sidney Topol/62	685,995	76.6%	Scientific-Atlanta	Chairman
55	C. Peter McCollough/55	685,310	23.8%	Xerox	Chairman executive committee
56	Jerry R. Jenkins/50	685,000	37.0%	Texas Instruments	President, CEO
57	Gordon E. Moore/59	684,419	85.7%	Intel	Chairman
58	Eugene R. White/56	682,915	8.7%	Amdahl	Vice president
59	John F. Mitchell/59	679,575	33.2%	Motorola	President, director
60	Marshall D. Butler/61	679,000	175.7%	AVX	Chairman
61	James L. Donald/55	678,574	75.2%	DSC Communications	President, CEO
62	Harold Falik/37	678,100	NA	Emerson Radio	Senior VP
63	Stanley A. Walner/61	670,000	21.8%	Wyle Laboratories	Chairman, CEO
64	K. V. Cassani/59	667,231	NA	IBM	Vice chairman
65	Mark Shepherd Jr./65	660,020	43.5%	Texas Instruments	Chairman
66	Bernard S. Appel	659,673	44.1%	Tandy	President Radio Shack div.
67	Jack D. Kuehler/55	656,126	23.5%	IBM	Vice chairman
68	Thomas A. Vanderslice/56	650,190	NA	Apollo	Chairman, CEO
69	John F. Gribi/45	650,000	140.7%	Compaq Computer	Senior VP finance, CFO
70	Luther Nussbaum/45	641,922	82.1%	Ashton-Tate	President, COO
71	Albert A. Eisenstat/57	640,000	60.8%	Apple Computer	Sr. VP, general counsel, secretary
72	Frank A. Brand/63	627,500	141.3%	M/A-COM	Senior VP, chief technical officer
73	William G. Moore Jr./48	624,077	-29.6%	Recognition Equipment	Chairman, president, CEO
74	Sing C. Tien	615,470	NA	Seagate Technology	Senior VP, Far East operations
75	E. Joseph Zemke/47	604,987	19.4%	Amdahl	President, COO, director
76	Robert W. Galvin/65	600,000	10.5%	Motorola	Chairman
77	Michael S. Swavely	600,000	NA	Compaq Computer	VP, sales & marketing
78	Thomas F. Burke/58	600,000	160.9%	M/A-COM	President, CEO, COO
79	Frederick A. Krehbiel/45	575,546	95.1%	Molex	Executive VP, president Molex Int'l
80	Winston R. Wallin/62	569,498	0.6%	Medtronic	Chairman, president, CEO
81	John A. Rollwagen/47	564,877	-9.2%	Cray Research	Chairman, CEO
82	James F. McDonald/48	559,225	-14.5%	Gould	Chairman, president, CEO
83	A. J. Krowe/55	557,408	NA	IBM	Executive VP
84	James M. Eckhart/56	555,000	96.6%	Compaq Computer	Senior VP corporate operations
85	David A. Bossen/61	543,000	6.7%	Measurex	President, CEO, director
86	Roger W. Johnson/53	542,375	23.2%	Western Digital	Chairman, president, CEO
87	Walter F. Raab/63	541,000	9.7%	AMP	Chairman, CEO, director
88	George M. Scallisa/54	538,418	NA	Maxtor	President, CEO
89	Donald J. Atwood/64	538,000	NA	General Motors	President GM Hughes Electronics
90	Donald Dvorkin/44	537,500	NA	Emerson Radio	Executive VP
91	Joseph T. Casey/56	535,056	NA	Litton Industries	Executive VP, CFO, director
92	William E. Terry/54	533,013	24.4%	Hewlett-Packard	Executive VP, director
93	Hollis L. Caswell	527,140	NA	Unisys	Senior VP
94	Charles M. Clough/59	520,000	4.0%	Wyle Laboratories	President, COO
95	Leslie L. Vadasz/51	519,774	84.0%	Intel	Senior VP
96	William E. Johnson/46	514,482	NA	Scientific-Atlanta	Vice chairman, CEO
97	James G. Traybig/47	513,405	47.7%	Tandem Computers	President, CEO, director
98	John J. Shields/57	512,233	26.5%	Digital Equipment	Senior VP
99	John F. Smith/52	511,114	26.2%	Digital Equipment	Senior VP
100	Joseph F. Caligiuri	508,698	NA	Litton Industries	Executive VP

¹ became chairman April 1987, resigned as president
NA = Not available

Source: ELECTRONIC BUSINESS

Capital spending: The boom will end, but '89 is no bust

Capital equipment vendors should enjoy 1988 while they can — 1989 forecasts call for a slower spending pace. Big-ticket buys could continue

BY LINDA STALLMANN
AND DAVID CARD

Forecasters expect electronics companies to slow their capital spending pace in 1989.

That's the bad news. The good news is that the comparison is relative to 1988, which will close out as a capital equipment boomlet.

The top 100 U.S. electronics companies spent \$14.3 billion on capital equipment last year, up 3.9% from what those same companies spent in 1986. (Only those companies from the ELECTRONIC BUSINESS 200 [July 15, 1988] that derive at least 70% of their total revenue from electronics are compared.) This year's growth will be even greater, as projections for some specific industry sectors suggest.

According to a survey by Lexington, Massachusetts-based Data Resources Inc., companies making electrical and electronic components will increase their spending this year by 42.7% compared with last year. The research firm shows spending by communication equipment companies up 13.6% in 1988, and office equipment makers up 25.8%.

But watch out for 1989, cautions DRI economist Nigel Gault. Preliminary budgeting plans at component companies call for only a 19% increase in 1989. And communication and office equipment suppliers will cut spending by 10% and 11.3%, respectively.

Gault points out that there is a "built-in tendency to underestimate spending plans," so 1989 probably will not be as bad as the early budgets indicate. Capital equipment vendors, Gault says, "shouldn't be planning on an increase like 1988, but

at the moment, it looks like 1989 will be a reasonably good year."

Caution on 1989 is the watchword with other forecasters too. If she were an equipment supplier, Elizabeth Baatz of Cahners Economics says, "I wouldn't be terrified, but I'd be keeping my eye open" looking toward 1989. Cahners Economics is pretty negative on the general economy, expecting a 1989 gross national product growth of only 1.1%.

Rebound in 1990

Cahners Economics forecasts manufacturing spending across all industries to increase 10.7% in 1988, but expects it to shrink 0.9% the next year. 1990 will rebound, with spending growing 5.2%. "Things people can order in smaller quantities will drop off sooner," Baatz says of 1989, indicating that spending on expensive items — automatic test equipment, for example — may hold up longer, but drop off in early 1990.

Last year, semiconductor companies spent the most on capital equipment as a percentage of sales. Custom

chip makers LSI Logic Corp. and VLSI Technology Inc. spent 67% and 29%, respectively.

However, the spree is over for now, says LSI Logic chief financial officer D. Scott Mercer. This year, he has cut spending by 66%, down to around \$60 million, anticipating pick-up to the \$80 million to \$100 million range in 1989.

So is Chrysler Corp.'s electronics assembly subsidiary; it bought some testers this year and is looking to add more. Computer-aided design and manufacturing equipment and surface-mount assembly equipment are also on plant manager Roger Rickey's shopping list. He expects to spend \$40 million to \$50 million over the next three or four years.

But are America's computer companies spending enough? Not according to Arthur D. Little Inc. analyst Jerry Wasserman. He evaluates a company's capital spending by comparing it with its net cash flow — the ratio of equipment spending to profits plus depreciation after dividends. Wasserman likes to see a 100% to 130% ratio, but in 1987, most of the big computer companies, for example, were nowhere near that ratio.

Wasserman speculates that they were watching the bottom line too closely. To compete against Japanese companies with their access to cheaper capital, managers in the United States must look further ahead, Wasserman insists. "We have got to have CEOs willing to stand up in front of the financial community and in front of their boards of directors," he says. "Unless they make the long-term investments, their companies are going to be buried." □



STRATEGIES

FINANCE

Top capital spenders

1987 rank	Company	Total capital expenditures (\$ millions)	Percentage change in expenditures from 1986	Capital expenditures as a percentage of revenue	Capital expenditures to net cash flow after dividends	Total company revenue (\$ millions)	Fiscal year ended
1	IBM	\$4,304.0	-6.8%	7.9%	70.2%	\$54,217.0	12/87
2	Xerox	937.0	-9.2%	9.1%	97.3%	10,320.0	12/87
3	DEC	748.4	32.6%	8.0%	47.6%	9,389.4	6/87
4	Unisys	720.9	30.3%	7.4%	75.4%	9,712.9	12/87
5	Motorola	658.0	11.0%	9.8%	91.5%	6,707.0	12/87
6	Hewlett-Packard	507.0	1.6%	6.3%	54.8%	8,090.0	10/87
7	GM Hughes Electronics	469.4	-33.0%	4.5%	56.1%	10,481.0	12/87
8	Texas Instruments	462.8	3.8%	8.3%	82.0%	5,594.5	12/87
9	NCR	389.2	7.9%	6.9%	62.4%	5,640.7	12/87
10	Honeywell	304.2	8.1%	4.6%	53.0%	6,679.3	12/87
11	Intel	301.5	94.8%	15.8%	86.9%	1,907.1	12/87
12	Pitney Bowes	251.8	20.6%	11.2%	88.9%	2,250.5	12/87
13	Litton Industries	242.8	-17.4%	5.5%	84.7%	4,419.7	7/87
14	Storage Technology	179.2	454.8%	23.9%	183.5%	750.0	12/87
15	Control Data	178.3	13.8%	5.3%	73.8%	3,366.5	12/87
16	LSI Logic	174.5	147.5%	66.6%	339.5%	262.1	12/87
17	AMP	171.8	13.3%	7.4%	57.6%	2,317.8	12/87
18	Amdahl	157.8	37.8%	10.5%	66.2%	1,505.2	12/87
19	Data General	142.9	10.1%	11.2%	576.1%	1,274.3	9/87
20	Tandem Computers	142.4	119.0%	13.7%	90.3%	1,035.5	9/87
21	Advanced Micro Devices	137.9	0.8%	13.8%	141.8%	997.1	12/87
22	Wang Laboratories	128.0	-45.2%	4.5%	42.8%	2,836.7	6/87
23	Compaq Computer	113.3	124.4%	9.3%	71.4%	1,224.1	12/87
24	Prime Computer	100.5	10.9%	10.5%	69.0%	960.9	12/87
25	National Semiconductor	94.7	-19.0%	5.1%	79.2%	1,867.9	5/87
26	Tandy	93.1	69.2%	2.7%	34.3%	3,452.2	6/87
27	Apple Computer	86.1	29.3%	3.2%	31.6%	2,661.1	9/87
28	Harris	83.6	-28.3%	4.0%	39.7%	2,079.0	6/87
29	Singer	78.7	-13.1%	4.1%	109.5%	1,902.7	12/87
30	Seagate Technology	78.4	102.7%	8.2%	46.8%	958.1	6/87
31	Sun Microsystems	76.1	110.2%	14.2%	124.0%	537.5	6/87
32	Tektronix	66.8	-2.4%	4.8%	49.5%	1,395.9	5/87
33	Perkin-Elmer	66.5	-2.9%	5.0%	492.2%	1,333.6	7/87
34	General Instrument	63.2	-13.8%	8.0%	103.7%	787.9	2/87
35	Microsoft	58.0	311.2%	16.8%	73.0%	345.9	6/87
36	Zenith Electronics	55.4	-9.2%	2.3%	247.3%	2,362.7	12/87
37	Apollo Computer	53.7	29.3%	9.7%	84.3%	553.7	12/87
38	E-Systems	51.1	7.0%	4.2%	68.3%	1,227.2	12/87
39	MiniScribe	50.5	139.5%	13.9%	128.2%	362.5	12/87
40	VLSI Technology	50.1	79.3%	29.1%	152.1%	172.0	12/87
41	Molex	49.5	23.3%	12.8%	65.2%	386.8	6/87
42	Gould	49.0	-14.3%	5.2%	51.2%	933.4	12/87
43	Avnet	47.3	109.7%	3.1%	146.5%	1,547.1	6/87
44	Varian Associates	46.2	-7.7%	4.7%	87.3%	982.8	9/87
45	Intergraph	43.7	-44.3%	6.8%	44.8%	641.1	12/87
46	Analog Devices	43.0	17.2%	11.6%	82.1%	370.4	10/87
47	Teradyne	41.0	34.9%	10.8%	374.1%	377.7	12/87
48	Western Digital	40.6	149.8%	8.8%	66.7%	462.5	6/87
49	Cray Research	40.2	-66.3%	5.8%	18.3%	687.3	12/87
50	Loral	34.2	-26.0%	5.0%	45.9%	690.0	3/87

Source: ELECTRONIC BUSINESS

(Continued)

STRATEGIES

FINANCE

Top capital spenders

1987 rank	Company	Total capital expenditures (\$ millions)	Percentage change in expenditures from 1986	Capital expenditures as a percentage of revenue	Capital expenditures to net cash flow after dividends	Total company revenue (\$ millions)	Fiscal year ended
51	AVX	\$31.8	187.4%	11.7%	91.9%	\$271.9	12/87
52	SCI Systems	29.6	172.1%	5.4%	104.8%	552.9	6/87
53	Augat	29.4	22.5%	9.4%	136.0%	313.2	12/87
54	Altos Computer	28.9	1,039.8%	18.8%	199.8%	153.9	6/87
55	Medtronic	28.4	469.6%	5.7%	32.3%	502.0	4/87
56	M/A-COM	26.7	-72.7%	6.1%	-295.1%	436.1	9/87
57	Lotus Development	26.6	71.1%	6.7%	30.3%	395.6	12/87
58	Applied Magnetics	25.7	148.4%	12.1%	98.8%	211.9	9/87
59	Datapoint	25.6	-2.8%	8.2%	-74.1%	312.1	7/87
60	Avantek	24.4	21.5%	11.4%	97.7%	213.7	12/87
61	Sprague Technologies	24.3	-38.2%	5.6%	76.2%	437.3	12/87
62	DSC Communications	23.2	21.5%	7.4%	53.5%	312.4	12/87
63	Micropolis	22.3	38.6%	7.7%	62.0%	288.3	12/87
64	Bolt Beranek and Newman	22.2	27.8%	9.5%	489.1%	233.8	6/87
65	Recognition Equipment	21.7	79.9%	8.2%	96.6%	264.7	10/87
66	Compugraphic	19.7	34.8%	5.4%	NA	367.1	12/87
67	Digital Communications	19.0	127.9%	10.5%	57.4%	181.4	6/87
68	Maxtor	17.4	125.8%	9.9%	66.1%	175.3	3/87
69	Cubic	17.1	98.6%	4.7%	118.8%	361.8	9/87
70	Oracle Systems	16.9	47.3%	12.9%	80.6%	131.3	5/87
71	Cherry Electrical	15.4	68.6%	9.6%	114.5%	160.6	2/87
72	General DataComm	15.3	-4.4%	7.6%	134.9%	200.6	9/87
73	Mentor Graphics	14.7	44.1%	6.6%	43.2%	221.8	12/87
74	Stratus Computer	13.8	-11.6%	7.5%	49.6%	184.2	12/87
75	LTX	13.6	156.0%	11.3%	283.6%	120.6	7/87
76	Kollmorgen	13.5	8.3%	4.5%	124.2%	301.0	12/87
77	CTS	13.4	-50.7%	5.1%	63.7%	261.1	12/87
78	MAI Basic Four	13.2	73.4%	4.1%	47.6%	321.0	9/87
79	Convergent	12.9	-62.8%	3.3%	NA	384.8	12/87
80	Dynatech	12.6	1.5%	4.1%	37.3%	304.7	3/87
81	Watkins-Johnson	12.3	-9.6%	4.7%	47.0%	264.3	12/87
82	Paradyne	12.2	-40.8%	5.2%	52.0%	232.6	12/87
83	Tandon	12.1	49.3%	4.2%	52.2%	289.1	12/87
84	Andrew	11.7	13.9%	5.2%	70.3%	223.2	9/87
85	GenRad	11.6	0.5%	6.0%	66.0%	193.8	12/87
86	Applied Materials	11.5	0.4%	6.6%	119.6%	174.4	10/87
87	ADC Telecommunications	11.1	10.3%	6.7%	47.5%	166.9	10/87
88	Cullinet Software	11.0	-59.2%	6.3%	-124.9%	174.9	4/87
89	Datapoints	11.0	20.8%	3.2%	60.2%	338.8	3/87
90	Gerber Scientific	10.6	49.6%	4.7%	41.4%	223.9	4/87
91	Westmark International	10.5	-37.4%	3.6%	366.7%	291.9	12/87
92	Computer Associates	10.4	71.2%	3.4%	16.4%	309.3	3/87
93	BRIntec	9.4	18.7%	3.2%	73.5%	293.7	12/87
94	Genicom	9.4	105.6%	3.1%	37.8%	302.2	12/87
95	Marshall Industries	9.2	-14.8%	3.2%	143.7%	286.6	5/87
96	Micom Systems	9.1	8.1%	4.6%	45.7%	196.7	3/87
97	ISC Systems	8.8	29.3%	5.2%	68.4%	168.5	6/87
98	Coherent	8.5	-4.4%	5.3%	222.4%	159.0	9/87
99	Diebold	8.4	-43.3%	1.9%	29.7%	439.1	12/87
100	Fluke	8.3	-8.3%	4.0%	66.9%	206.3	9/87

Source: ELECTRONIC BUSINESS

(Continued)

Top capital spenders by segment

Capital expenditures FY 1987

	Total (\$ millions)	As a percentage of revenue
Semiconductors		
Motorola	\$658.0	9.8%
Texas Instruments	462.8	8.3%
Intel	301.5	15.8%
LSI Logic	174.5	66.6%
Advanced Micro Devices	137.9	13.8%
National Semiconductor	94.7	5.1%
Harris	83.6	4.0%
VLSI Technology	50.1	29.1%
Gould	49.0	5.2%
Analog Devices	43.0	11.6%
Western Digital	40.6	8.8%
International Rectifier	6.0	4.0%
Total, weighted avg. ..	\$2,101.7	9.8%

Communications

Motorola	\$658.0	9.8%
General Instrument	63.2	8.0%
M/A-COM	26.7	6.1%
Avantek	24.4	11.4%
DSC Communications	23.2	7.4%
Bolt Beranek and Newman	22.2	9.5%
Digital Communications	19.0	10.5%
General DataComm	15.3	7.6%
Dynatech	12.6	4.1%
Paradyne	12.2	5.2%
Andrew	11.7	5.2%
ADC Telecommunications	11.1	6.7%
Micom Systems	9.1	4.6%
Scientific-Atlanta	6.7	1.4%
3Com	6.3	5.7%
TIE/communications	4.3	1.7%
Aydin	4.1	2.8%
Dynascan	1.7	0.9%
Total, weighted avg.	\$931.8	8.2%

Minicomputers

IBM	\$4,304.0	7.9%
DEC	748.4	8.0%
Hewlett-Packard	507.0	6.3%
Data General	142.9	11.2%
Tandem Computers	142.4	13.7%
Prime Computer	100.5	10.5%
Sun Microsystems	76.1	14.2%
Apollo Computer	53.7	9.7%
Gould	49.0	5.2%
Stratus Computer	13.8	7.5%
MAI Basic Four	13.2	4.1%
Computer Consoles	4.9	3.3%
Total, weighted avg. ...	\$6,155.9	7.9%

Office equipment

IBM	\$4,304.0	7.9%
Xerox	937.0	9.1%
NCR	389.2	6.9%
Pitney Bowes	251.8	11.2%
Wang Laboratories	128.0	4.5%
Harris	83.6	4.0%
Datapoint	25.6	8.2%
Diebold	8.4	1.9%
Savin	1.2	0.3%
Total, weighted avg. ...	\$6,128.7	7.8%

Mainframes

IBM	\$4,304.0	7.9%
Unisys	720.9	7.4%
NCR	389.2	6.9%
Control Data	178.3	5.3%
Amdahl	157.8	10.5%
Cray Research	40.2	5.8%
Total, weighted avg. ...	\$5,790.4	7.7%

Components

AMP	\$171.8	7.4%
Molex	49.5	12.8%
AVX	31.8	11.7%
Augat	29.4	9.4%
Sprague Technologies	24.3	5.6%
Cherry Electrical	15.4	9.6%
CTS	13.4	5.1%
BRIntec	9.4	3.2%
Oak Industries	6.2	3.4%
Total, weighted avg.	\$351.2	7.6%

Software

Microsoft	\$58.0	16.8%
Lotus Development	26.6	6.7%
Oracle Systems	16.9	12.9%
Mentor Graphics	14.7	6.6%
Cullinet Software	11.0	6.3%
Computer Associates	10.4	3.4%
Ultimate	7.9	4.6%
Ashton-Tate	6.5	2.4%
Total, weighted avg.	\$152.1	7.5%

Microcomputers

IBM	\$4,304.0	7.9%
Compaq Computer	113.3	9.3%
Tandy	93.1	2.7%
Apple Computer	86.1	3.2%
Zenith Electronics	55.4	2.3%
Altos Computer	28.9	18.8%
Tandon	12.1	4.2%
AST Research	6.3	3.0%
Atari	4.1	0.8%
Total, weighted avg. ...	\$4,703.3	7.2%

Peripherals

Storage Technology	\$179.2	23.9%
Control Data	178.3	5.3%
Seagate Technology	78.4	8.2%
MiniScribe	50.5	13.9%
Applied Magnetics	25.7	12.1%
Micropolis	22.3	7.7%
Maxtor	17.4	9.9%
Tandon	12.1	4.2%
Dataproducts	11.0	3.2%
Genicom	9.4	3.1%
Wyse Technology	8.1	3.1%
AST Research	6.3	3.0%
Quantum	5.9	4.9%
Cipher Data Products	5.8	3.3%
Decision Industries	4.9	2.6%
Intelligent Systems	2.8	1.7%
Xidex	2.2	0.4%
Total, weighted avg.	\$620.2	7.1%

Government

Motorola	\$658.0	9.8%
GM Hughes Electronics	469.4	4.5%
Texas Instruments	462.8	8.3%
Honeywell	304.2	4.6%
Litton Industries	242.8	5.5%
Harris	83.6	4.0%
Singer	78.7	4.1%
E-Systems	51.1	4.2%
Gould	49.0	5.2%
Varian Associates	46.2	4.7%
Loral	34.2	5.0%
SCI Systems	29.6	5.4%
Cubic	17.1	4.7%
Watkins-Johnson	12.3	4.7%
Aydin	4.1	2.8%
Logicon	3.8	1.9%
Total, weighted avg. ...	\$2,547.0	5.9%

Capital equipment

Hewlett-Packard	\$507.0	6.3%
Tektronix	66.8	4.8%
Perkin-Elmer	66.5	5.0%
Varian Associates	46.2	4.7%
Teradyne	41.0	10.8%
LTX	13.6	11.3%
GenRad	11.6	6.0%
Applied Materials	11.5	6.6%
Gerber Scientific	10.6	4.7%
Fluke	8.3	4.0%
Sun Electric	4.6	2.3%
Esterline	2.7	1.0%
Total, weighted avg.	\$790.3	5.8%

Computer-based systems

Hewlett-Packard	\$507.0	6.3%
Honeywell	304.2	4.6%
Intergraph	43.7	6.8%
Recognition Equipment	21.7	8.2%
Gerber Scientific	10.6	4.7%
ISC Systems	8.8	5.2%
Coherent	8.5	5.3%
Measurex	6.9	3.0%
Sun Electric	4.6	2.3%
Total, weighted avg.	\$916.0	5.5%

Medical

Medtronic	\$28.4	5.7%
Westmark International	10.5	3.6%
Diasonics	8.1	3.0%
Total, weighted avg.	\$47.0	4.4%

Distributors

Avnet	\$47.3	3.1%
Marshall Industries	9.2	3.2%
Wyle Laboratories	3.8	1.0%
Pioneer-Standard	2.3	1.1%
Arrow Electronics	2.2	0.4%
Anthem Electronics	0.9	0.5%
Total, weighted avg.	\$65.7	2.1%

Source: ELECTRONIC BUSINESS

Distributors are back on track after two-year slump

Led by a booming semiconductor demand, electronics distributors' sales are climbing. But a market consolidation could hurt the smaller players

BY DWIGHT B. DAVIS

After two years of being battered by the mid-80s electronics industry slump, industrial distributors struggled back to their feet in 1987. The year finished strongly despite a weak start, with distributor sales surpassing the \$7 billion mark for the first time. The recovery has continued this year — thanks in large part to the booming semiconductor sector — and most distributors expect the resurgence to stretch well into 1989.

Based on estimates that the semi-

conductor industry will grow 25% to 30% during 1988, Prudential-Bache Securities Inc. predicts that distributors will experience a 20% revenue surge this year, up to a total of \$8.4 billion. Wall Street's Bear Stearns & Co. is a little less bullish, predicting roughly 13% growth to a \$7.9 billion level. Semiconductor sales traditionally account for about 40% of total distribution revenue, although the percentage has been slightly lower in recent years. Prudential-Bache sees

the overall market growth continuing at a still respectable 15% rate in 1989, according to analyst Elizabeth Dorsey.

Other observers expect somewhat lower growth next year, based partly upon widely held assumptions that 1989 may play host to a cyclical economic contraction. But distributors should be well positioned to continue slow growth even in a recessionary environment, as long as they are better able to manage their inventories than during the previous downturn, says Toby Mack, executive vice president of the National Electronic Distributors Association (NEDA).

In any case, a general economic slowdown may not be as important to distributors as the simple issue of component supply and demand, notes Mike Worfolk, president of Schweber Electronics. He points out that most of the growth in the first half of 1988 was fueled by product shortages and increased prices, not by higher levels of unit shipments. Given that component supplies are expected to improve toward year-end and into 1989, Worfolk expects growth in the 5% to 10% range in 1989.

Gross profit margins, meanwhile, hovered around 23% in 1987, Dorsey says, below the 25% margins typical in strong years. Profit margins should approach their traditional levels this year, she predicts, due in part to the continuing DRAM shortage, keeping prices of that key commodity high. As a caveat to this predicted improvement, however, Dorsey notes that an increased reliance on systems sales with their lower margins could adversely affect overall profits.

Downward pressure could also be exerted on margins as more suppliers attempt to cut their costs by reducing the number of OEM customers with



Economic slowdown may not be as important to distributors as the simple issue of component supply and demand, says Schweber president Mike Worfolk

JONATHAN LEVINE

which they deal directly, says Tom Calder, vice president for marketing at Marshall Industries. "As these suppliers turn more to industrial distributors, competition in the field will increase," he says, "and that will keep margins tight."

While distributors believe the worst is behind them, the 1985-86 recession has had a lasting impact on the nature of their business. Gone are the days when the companies could profit by doing little more than stocking large inventories and providing one-stop shopping for OEMs and other value-added resellers. Suppliers are now demanding that the middlemen keep them better informed about shifts in customer demand. At the same time, "Our customers are energetically trying to reduce their expenses by calling upon us to perform a variety of value-added services," says Anthony Hamilton, chairman of Avnet Inc.

Market restructuring

These market demands have begun to alter the basic character of the distribution business. Market consolidation has accelerated as the players attempt to gain greater economies of scale, more diverse product lines, and broader geographic representation. At the same time, the major distributors are branching out by providing value-added services such as component customization, testing and inspection; by setting up electronic data interchange (EDI) connections with their suppliers and customers; and by increasing their activity in the fast-growing systems sales marketplace.

The just-in-time production philosophy is playing a key role in much of this restructuring. OEMs and other integrators are looking to cut their inventory costs by keeping on-site stocks at a bare minimum. As such, they're relying upon distributors to keep the necessary components and peripherals in their warehouses ready for immediate shipping to keep the production pipeline flowing. To further expedite this process, many distributors are setting up "in-house stores" at their customers' sites. The distributor owns these inventories, but the customer agrees to maintain them on-site for rapid availability.

JIT arrangements not only require that the distributors provide all necessary components at a moment's notice, but that the parts arrive at the

Top distributors — Product breakdown				
	Computers	Active components	Passive components	Other
Avnet	27%	43%	22%	8%
Arrow Electronics	35%	50%		15%
Lex	15%	58%		27%
Hall-Mark	25%	50%		25%
Marshall Industries	20%	60%		20%
Pioneer-Standard	37%	32%	27%	4%
Premier Industrial		NA		
Future	10%	65%		25%
Wyle Laboratories	30%	60%		10%
Bell Industries		NA		
Anthem Electronics	30%	70%		
Zeus		95%		5%

FY 1987 data

Source: ELECTRONIC BUSINESS

customers' doors error free. To meet this demand, distributors have beefed up their quality control and inspection departments, removing these responsibilities from their customers' shoulders.

Another related service, that of "kitting," is also much in demand. Kitting can range from simple prepackaging and shipment of related groups of components to actual subsystem assembly and programming. Schweber's-Worfolk notes that the term "preproduction" might better

Distributors hope for a 15% to 20% surge in revenue and better profit margins

describe the kitting operation. "We can source the production and deal with the 30 to 40 vendors supplying parts rather than have our customers perform that task," he explains.

Communications networks

To efficiently manage these expanded activities, distributors are setting up on-line connections between themselves and their suppliers and customers. Through such EDI programs, "we're working to facilitate the information flow," says Hall-

Mark Electronics president Joe Semmer. "Our customers load us up with orders, and we, in turn, load up our suppliers with orders."

So far, though, most EDI setups consist only of customer-site terminals linked to the distributors' mainframes. While these facilitate ordering and the transfer of technical product information, they fall far short of the full potential of EDI, says Worfolk. That potential will only be realized through the advent of mainframe-to-mainframe links that will let customer and distributor host computers communicate directly, he says. Such links will further augment ordering and invoicing automation, but they must wait until EDI communications standards are hammered out by groups such as the American National Standards Institute.

Even with the growing emphasis on electronic links between the parties, the distributors still lack good methods with which to monitor and analyze fluctuations in supplier and customer inventories, says Mack at the NEDA. As long as this is the case, he warns, the industry will be vulnerable to rumors about impending parts shortages and to the double and triple bookings that customers place to protect themselves when supplies get tight. "A better tracking model would go a long way toward damping out the wide inventory gyrations that have occurred in the past," Mack says. ▢

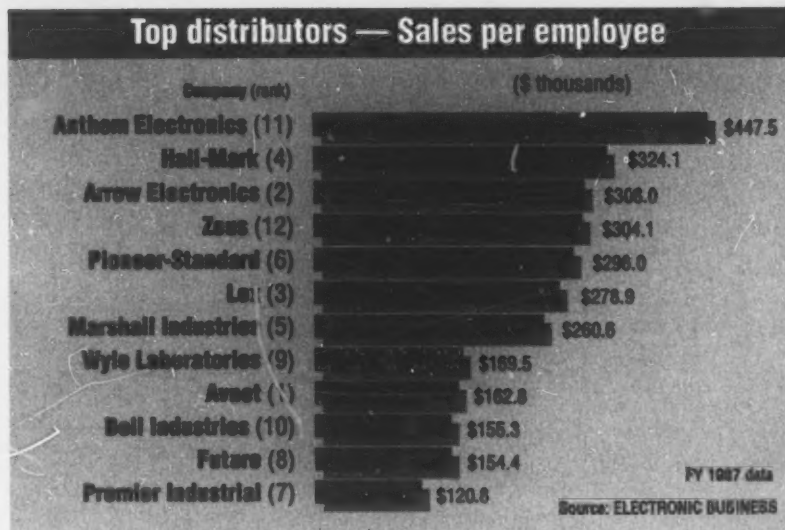
For their part, distributors are struggling to maintain market share and improve profit margins in a dynamic business that is increasingly dominated by a few large players. Longtime leader Avnet accounted for about \$1.3 billion of the industry's \$7.4 billion total sales in calendar year 1987, up 12.1% from the previous year's revenue.

Avnet's Hamilton/Avnet division hopes to hold its lead in part through a restructuring move that separates its electronic components business from its growing computer systems and peripherals business. The company has virtually completed a major inventory centralization, with a flagship "megawarehouse" in Chandler, Ariz. Also in Chandler is a new IBM 3090-200E mainframe, which is being networked to the company's 4,000 nationwide terminals.

Small firms get squeezed

"The ability of the large distributors to feed off a few centralized warehouses permits them to set up simple sales offices rather than complete inventories around the country," notes Fred Wolf, an analyst with Mabon, Nugent & Co. "This gives them better cost efficiencies and may result in the squeezing out of some of the smaller distributors," he says.

Arrow Electronics Inc. also in-



creased its revenue 12.1% in 1987, to a total of \$562 million. The company lost \$15.8 million on those sales, but that bad news was quickly mitigated as Arrow successfully completed its acquisition of the distribution units of Ducommun Electronics Inc. this January. If the 1987 sales of these units — Kierulff Electronics, Ducommun Data Systems and MTI Systems — had been combined with Arrow's, the resulting revenue would have totaled about \$940 million.

The success with which Arrow has combined its new and old operations has surprised competitors and analysts alike. The company's average daily order rate rose from \$2.6 million during 1987's fourth quarter to \$4.6 million in this year's first quarter. That rate surpassed the combined preacquisition order rates of the two companies, and analyst Dorsey believes Arrow should easily attain its stated goal of reaching \$1 billion in revenue this year. "They've

Top U.S. electronics distributors

1987 rank	Company	Calendar year distribution revenue (\$ millions)		Percentage change	Distribution as a percentage of total company revenue	FY 1987 revenue (\$ millions)	FY 1987 pretax profit (\$ millions)	Pretax profit as a percentage of total revenue	FY 1987 net income (\$ millions)
		1987	1986						
1	Avnet	\$1,285	\$1,146	12.1%	77%	\$1,547.1	\$46.6	3.0%	\$22.6
2	Arrow Electronics ¹	562	502	12.1%	100%	562.4	-15.8	-2.8%	-15.8
3	Lex ²	541	501	8.0%	23%	541.0	5.6	1.0%	NA
4	Hall-Mark	475	385	23.5%	100%	475.4	-9.5	-2.0%	-6.1
5	Marshall Industries	356	269	32.1%	100%	286.6	11.0	3.8%	5.1
6	Pioneer-Standard ³	320	276	15.9%	100%	254.6	8.6	3.4%	5.2
7	Premier Industrial	297	267	11.2%	61%	459.0	81.4	17.7%	48.3
8	Futura	270	217	24.3%	100%	270.2	NA	NA	3.0
9	Wyle Laboratories	265	225	18.2%	72%	368.0	10.5	2.9%	5.8
10	Ball Industries	199	158	25.9%	49%	357.1	6.9	1.9%	3.3
11	Anthem Electronics	197	167	17.8%	100%	196.9	9.1	4.6%	5.0
12	Zuss	91	92	-0.7%	100%	89.1	-1.7	-1.9%	-1.0

¹ Acquired Ducommun's distribution business Jan. 1988. If the acquisition had been made on Jan. 1, 1987, pro forma combined sales would have been \$940 million.

² Data for U.S. distribution operations only.

³ Includes sales of 50% owned Pioneer Technologies Group Inc. with fiscal 1986 sales of \$91.7 million.

done an amazing job of assimilating the two companies," she says.

The downside of the acquisition is the further leveraging of the parent company. In 1987, Arrow's debt as a percentage of total capital was 39.5%; after the acquisition it rose to about 66%, according to Dorsey. Arrow had to pay \$7.2 million in interest in the first quarter of this year.

Troubling high debt

High debt as a percentage of total capital is endemic in the industry — typically spanning the 35% to 45% range — and analysts warn that distributors might have a hard time financing their operations should another slump occur. Still, this year's strong economic performances should help lower this statistic.

Another factor boosting this year's outlook is the impact of the 1986 Tax Reform Act. In fiscal year 1987, Avnet's net income fell from the previous year — from \$23.9 million to \$22.8 million — largely because its tax rate rose from 43.6% in fiscal '86 to 51.1% in fiscal '87. For the fiscal year closed June 30, 1988, Avnet's rate fell to about 39%.

No. 3 distributor Lex Services Plc announced a major restructuring of its Schweber Electronics division in mid-July. The changes include realignment of the firm's five regions

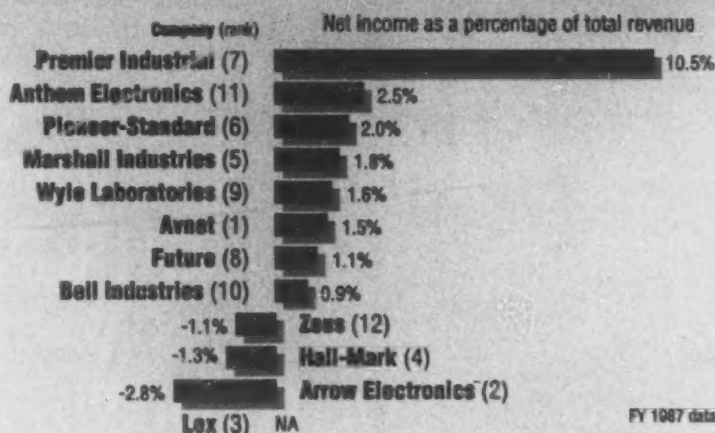
and the establishment of sales and marketing, technology, regional services and operations managers for each region.

The fourth largest distributor, Hall-Mark, went against the consolidation trend in early July when its management team announced a plan to buy the company from parent Tyler Corp. Previously, Hall-Mark had been the subject of much takeover speculation. At press time, the deal had been signed, but not yet final-

ized, according to Semmer.

Fifth-ranked Marshall outperformed the rest of the top companies in 1987, with revenue jumping 32.1% over calendar year 1986 sales. The company continues to rely heavily upon its Japanese sourced product lines; approximately 19% of Marshall's 1987 sales were of Japanese products, making the company the largest distributor of these lines in the United States, according to marketing vice president Calder. □

Top distributors — Net income/total revenue



FY 1987 data

Source: ELECTRONIC BUSINESS

Net income as a percentage of total revenue	Return on equity	Return on investment	Cost of goods as a percentage of revenue	Sales per employee (\$ thousands)	Net income per employee (\$ thousands)	Five-year growth (Compounded average annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Fiscal year ended
						Revenue	Net income			
1.5%	3.5%	2.6%	73.5%	\$162.8	\$2.4	6.8%	-16.5%	146.5%	25.7%	6/87
-2.8%	-16.4%	-10.0%	79.4%	308.0	-8.7	5.8%	NM	-13.0%	39.5%	12/87
NA	NA	NA	NA	278.9	NA	20.7%	NA	NA	NA	12/87
-1.3%	NA	NA	77.7%	324.1	-4.2	25.2%	NA	NA	NA	12/87
1.8%	9.4%	5.1%	75.1%	260.6	4.7	19.4%	NM	143.7%	45.7%	5/87
2.0%	15.4%	5.8%	75.2%	296.0	6.1	16.5%	53.7%	27.5%	62.5%	3/88
10.5%	18.1%	17.6%	51.5%	120.8	12.7	6.7%	6.9%	10.7%	2.5%	5/87
1.1%	NA	NA	NA	154.4	1.7	25.0%	-5.1%	NA	NA	12/87
1.6%	6.5%	4.3%	76.7%	169.5	2.7	13.4%	NM	49.1%	33.5%	1/88
0.9%	3.1%	2.4%	75.0%	155.3	1.4	11.8%	-15.3%	87.4%	23.0%	6/87
2.5%	7.3%	6.7%	76.7%	447.5	11.4	38.5%	27.3%	15.0%	7.5%	12/87
-1.1%	-5.9%	-2.4%	76.6%	304.1	-3.3	14.9%	NM	-461.6%	59.1%	9/87

NA = Not available
NM = Not meaningful

Source: ELECTRONIC BUSINESS

Since Black Monday, the spotlight's been on ROI

Suddenly, investors are concerned. And when Wall Street talks, everyone listens. High-technology firms like Cray and Compaq are focusing on ROI and ROE as well

BY RAY WISE

Generating high rates of return on investment can help a technology company keep growing and enhance the attractiveness of its shares, especially in a nervous stock market. And since October of 1987, the market has been nervous indeed. So, while investor concern over return on investment and equity appeared minimal during Wall Street's "trip to the moon on gossamer wings," these traditional measures have become increasingly important since that trip's disastrous end on Black Monday. "Investors are paying a lot more attention to such fundamentals as ROI and ROE," reports Rich Spillane, who runs the Fidelity Select Portfolio in Boston.

Last year, U.S. industry averaged a 10% return on investment. Even in technology, where returns tend to be above average, 20% is considered high. Yet, Minneapolis-based Cray Research Inc. produced an ROI of 20.2% in 1987 and 21.7% the previous year. Meanwhile, Compaq Computer Corp., with headquarters in Houston, last year boosted ROI to 24.8% from the year-earlier 16.7% and expects another 20%-plus performance this year. And Western Digital Corp., Irvine, Calif., attained a 20.3% ROI in 1987, a quantum leap from the year-earlier 13%. And leading software companies' ROIs hover around 30%.

A variety of factors can contribute to increased ROI. Finely honed forecasting techniques and careful capital marketing

financing certainly help. Moreover, Cray is an example of one of the most important factors in keeping ROI high: product differentiation.

"Cray is the highest of high technology," says Warren K. Greene, president of the American Investors group of mutual funds in Greenwich, Conn. "Once you have reached that level, it is hard for anybody, even the Japanese, to catch you. Cray is in a world of its own."

While Cray's chief financial officer, John F. Carlson, does not shrug off the competition so readily, he generally agrees with Greene's assessment. "We are a single-product company with a clear vision," Carlson says. "Our products help customers do things they could not otherwise

do. And to continue that product dominance, we spend 15% of revenues on research and development."

Product superiority can push up ROI because profitability reflects price, and price is driven by the product. Cray's supercomputers can simulate the effect of a wind tunnel in the design of an aircraft; test the durability of an auto without smashing it into a brick wall; and help oil companies find and recover petroleum deposits with maximum efficiency. Until now, it's been difficult for customers to find a cheaper model. Consequently, Cray has two-thirds of the worldwide supercomputer market, including an awesome 80% outside Japan. And the firm's machines fetch \$2.5 million to \$20 million each.

More than ever before, though, Cray is facing competition. In Japan, Hitachi Ltd. and NEC Corp. are making supercomputers, and Fujitsu Ltd. is also having a go at it. IBM would like to enter the market, Carlson says, but probably not the high end, which is Cray's exclusive turf. But Cray wants more volume in the middle because, according to Carlson, "it is questionable how much more the top end can grow."

Another company benefiting from a high degree of product differentiation is Compaq Computer Corp., mainstay of the portable computer business and a big player in the IBM-compatible desktop market. Long term, company officials say, returns should be boosted even higher than the current high rates by a recently unveiled product at the high



ROI leader Cray Research Inc.'s CFO John Carlson: "We are a single product company with a clear vision"

end of the desktop computer line.

Compaq's high returns are the result of sound growth management, according to Daryl J. White, corporate controller. And that in turn, he says, is at least partially due to the company's deft timing of capital financings. Unless this cycle is finely tuned, a company can wind up with overcapitalization and excess capacity, or undercapitalization and too little capacity. Complicating matters are the vagaries of the capital markets and the necessity of responding swiftly when a market window opens.

Encountering a window in the bond market last spring, Compaq sold \$200 million of 6.25% convertible debentures, raising its long-term debt to a highly respectable 25% of total capitalization. The capital structure of an average manufacturing company is 50% equity, 50% debt. Debt is cheaper than equity, says White, "and so you waste corporate resources by expanding with equity capital alone."

Compaq's growth has been dizzying recently, with 1988 sales expected to surge nearly 60% to \$1.9 billion from last year's \$1.2 billion — and this can cause problems. "When you are growing at such a rapid pace, in general, selling and administrative expenses can accelerate extremely fast," says White.

Another strong advocate of finely honed forecasting is Bert Moyer, CFO of Western Digital, whose sales of board-level subsystems and other products soared 66% last year and should jump a similar amount in 1988. "You have to forecast where your business is going," Moyer urges. "We like to keep our expansion a little short of our expectations." Moyer says some CFOs, to their eventual sorrow, seek to keep slightly ahead of demand. But then "only slightly" turns into "more than slightly."

Exacerbating this is the rapidly changing technology of the capital equipment itself and the corporate love affair with staying on the leading edge of manufacturing know-how. "We tend to get wrapped up in our own technology," says Moyer, who stresses that attainment of maximum manufacturing efficiency can be an outright error, depending on whether the corporate strategy is to achieve cost leadership, product differentiation or market focus.

"Only when you seek cost leader-

ship does it make sense to try to keep on the leading edge of manufacturing cost control," Moyer advises. According to this view, a product differentiation company like Cray or Compaq, or a market-focus enterprise like Sun Microsystems Inc., which concentrates intensely on the engineering marketplace, does not need to invest heavily in production cost control.

As a product's sales volume expands, a shift from product differentiation to a cost-leadership strategy may be called for, according to Moyer. "When the market for a product enlarges substantially, competition is attracted and cost becomes a factor.

Moyer cites Western Digital's entry



Compaq's controller Daryl White: Look for the open window in the capital markets

into the manufacture of video graphics components. To attain market penetration for the line, the company adopted a product differentiation approach. As volume expanded, Western Digital invested heavily in manufacturing capability to drive prices down and competitors out. As a result, Western Digital now has a huge 65% share of the \$400 million market for video graphics components.

In part, returns on investment and equity reflect the corporate asset base, which determines the size of the denominators in the ratios. All other things being equal, it would be unreasonable to expect an integrated steel company to generate returns as high as a consulting firm or advertising agency. Return on investment (ROI)

measures how efficiently management uses corporate assets and how well it preserves shareholder values. It is the ratio of net earnings to the total capital employed in the business, often consisting of both debt and equity. In the absence of long-term debt, ROI equals return on equity (ROE).

Viewed as a manufacturing company, Apple Computer Inc. would inspire awe for its 26% return on investment last year and its prospects for topping 30% in 1988. But, in fact, Apple farms out so much of its manufacturing that it qualifies as an organization of product designers. It does however, invest in people, rather than plant and equipment, with the emphasis on sales representatives and customer engineers. "We have 100 such people today and would like to have 200," says Deborah Coleman, Apple's CFO. Apple has advanced from selling just boxes to selling marketing solutions to customer problems, a transformation that mandates expansion of the field force.

If Apple is people-oriented, the software industry is even more so. "Our capital requirements are far different from those of a hardware company," says Jeffrey L. Walker, senior vice president and chief financial officer of Oracle Systems Corp. "We invest in people rather than in plants. Essentially, we have no capital requirements."

Lotus Development Corp. employs 2,400, more than 70% of them professionals, and keeping the workforce satisfied is a major corporate priority, as evidenced by annual employee opinion surveys that sound out attitudes toward management. Lotus also makes a point of determining the needs and problems of its customers. Major clients, for example, are brought into corporate headquarters in Cambridge, Mass., for executive briefings. "It seems to work," according to Martin Fahey, director of investor relations. "We've sold 4 million spreadsheets and they are being used by 7 million to 8 million people."

There is a limit to how much a software firm can reinvest in itself by hiring people, says CFO Frank Gaudette of Microsoft Corp., "because people can be absorbed only so fast. However, we are in a growth mode and we are hiring." □

Top ROI performers in U.S. electronics

Rank	Company	Return on investment		Return on equity		Fiscal 1987 sales (\$ millions)	Fiscal 1987 profits (\$ millions)	Fiscal year ended
		1987	1986	1987	1986			
1	Lotus Development	30.0%	32.8%	35.7%	42.1%	\$395.6	\$72.0	12/87
2	Oracle Systems	29.3%	16.1%	31.9%	18.9%	282.1	42.9	5/88
3	Microsoft	29.2%	28.2%	30.1%	28.2%	345.9	71.9	6/87
4	Apple Computer	26.0%	5.7%	26.0%	5.7%	2,661.1	217.5	9/87
5	Compaq Computer	24.8%	16.7%	34.1%	23.4%	1,224.1	136.3	12/87
6	Ashton-Tate	23.0%	22.9%	24.1%	24.6%	267.3	43.1	1/88
7	Seagate Technology	21.3%	15.4%	39.5%	16.6%	958.1	139.7	6/87
8	Western Digital	20.3%	13.0%	21.2%	22.8%	462.5	42.8	6/87
9	Cray Research	20.2%	21.7%	24.1%	28.2%	687.3	147.1	12/87
10	Inmac	20.0%	19.8%	22.9%	34.8%	165.4	7.7	7/87
11	ADC Telecommunications	19.3%	18.7%	20.1%	19.8%	166.9	15.3	10/87
12	Medtronic	19.0%	17.4%	21.9%	19.1%	653.3	86.5	4/88
13	NCR	17.7%	13.0%	19.4%	14.0%	5,640.7	419.3	12/87
14	MAI Basic Four	17.6%	15.9%	29.3%	31.4%	321.0	22.8	9/87
15	Stratus Computer	17.6%	16.3%	18.9%	17.9%	184.2	19.4	12/87
16	DEC	17.3%	10.1%	18.1%	10.8%	9,389.4	1,137.4	6/87
17	Digital Communications	17.2%	17.3%	17.2%	17.3%	181.4	27.0	6/87
18	Computer Associates	16.4%	9.2%	20.4%	14.5%	709.1	101.8	3/88
19	Intelligent Systems	16.4%	0.1%	24.7%	0.1%	163.2	10.2	12/87
20	AMP	16.3%	12.4%	18.5%	14.5%	2,317.8	249.7	12/87
21	Gorber Scientific	15.6%	11.7%	17.5%	13.1%	264.0	29.6	4/88
22	Amdahl	15.4%	5.7%	18.5%	7.9%	1,505.2	142.0	12/87
23	Tandy	15.3%	11.8%	17.6%	15.1%	3,452.2	242.3	6/87
24	Measurox	15.2%	13.3%	15.8%	13.9%	227.4	26.8	11/87
25	Tandon	15.2%	-101.4%	18.3%	-122.7%	289.1	17.1	12/87
26	Logicon	15.0%	10.5%	15.0%	10.5%	218.9	9.1	3/88
27	Tandem Computers	14.4%	11.7%	14.6%	11.9%	1,035.5	105.6	9/87
28	Atari	14.2%	23.3%	26.3%	23.8%	493.2	44.2	12/87
29	3Com	14.0%	12.9%	14.4%	13.2%	251.9	22.5	5/88
30	MiniScribe	14.0%	22.3%	27.8%	30.6%	362.5	28.1	12/87
31	Pitney Bowes	13.5%	14.3%	19.2%	18.2%	2,250.5	199.4	12/87
32	Molex	13.3%	12.0%	13.7%	12.6%	386.8	43.4	6/87
33	AST Research	13.1%	31.0%	13.1%	31.4%	206.0	13.0	6/87
34	Micropolis	12.7%	16.5%	19.6%	16.5%	288.3	27.2	12/87
35	Intergraph	12.2%	13.7%	12.3%	14.2%	641.1	69.9	12/87
36	Dynatech	12.1%	14.1%	16.1%	19.2%	367.8	24.5	3/88
37	Diasonics	12.1%	-18.8%	14.4%	-22.7%	267.6	15.2	12/87
38	Watkins-Johnson	12.0%	13.3%	14.7%	16.8%	264.3	17.1	12/87
39	IBM	12.0%	12.0%	13.7%	13.9%	54,217.0	5,258.0	12/87
40	E-Systems	11.8%	13.8%	14.1%	16.3%	1,227.2	60.4	12/87
41	Scientific-Atlanta	11.6%	-4.3%	12.0%	-5.1%	495.3	24.3	6/87
42	Marshall Industries	11.4%	4.7%	15.8%	8.4%	420.4	17.6	5/88
43	Aydin	11.1%	10.7%	12.6%	11.6%	149.2	8.8	12/87
44	Hewlett-Packard	10.6%	10.9%	12.8%	11.8%	8,090.0	644.0	10/87
45	Mentor Graphics	10.5%	6.2%	10.8%	7.1%	221.8	20.3	12/87
46	Diebold	10.3%	10.6%	10.5%	10.9%	439.1	35.8	12/87
47	Ultimate	10.0%	14.5%	12.6%	15.5%	209.2	13.0	4/88
48	Wyse Technology	9.9%	10.2%	17.0%	19.6%	456.6	28.0	3/88
49	Texas Instruments	9.2%	2.0%	11.4%	2.3%	5,594.5	256.9	12/87
50	Applied Magnetics	9.2%	4.0%	9.5%	4.1%	211.9	14.2	9/87

(Continued)

Top ROI performers in U.S. electronics

Rank	Company	Return on investment		Return on equity		Fiscal 1987 sales (\$ millions)	Fiscal 1987 profits (\$ millions)	Fiscal year ended
		1987	1986	1987	1986			
51	General Instrument	9.1%	2.8%	12.0%	4.0%	\$1,155.5	\$66.2	2/88
52	Dynascan	9.1%	8.2%	14.5%	16.2%	191.6	6.6	12/87
53	Sun Microsystems	9.0%	9.4%	15.1%	11.0%	537.5	36.3	6/87
54	Unisys	8.7%	-0.7%	12.7%	-1.1%	9,712.9	578.0	12/87
55	Intel	8.5%	-10.9%	13.4%	-14.4%	1,907.1	175.5	12/87
56	Motorola	8.3%	5.7%	10.2%	7.0%	6,707.0	308.0	12/87
57	Computer Consoles	8.1%	-2.6%	29.9%	-23.1%	148.4	9.6	12/87
58	Avantek	7.5%	10.9%	7.5%	10.9%	213.7	11.6	12/87
59	Xerox	7.5%	6.8%	10.4%	9.5%	10,320.0	578.0	12/87
60	Genicom	7.5%	12.9%	21.5%	18.9%	302.2	12.6	12/87
61	Harris	7.4%	5.4%	8.6%	6.6%	2,079.0	84.5	6/87
62	Altos Computer Systems	7.4%	18.7%	9.1%	19.8%	153.9	9.7	6/87
63	Loral	7.0%	5.1%	17.0%	15.8%	1,440.8	74.3	3/88
64	Honeywell	7.0%	0.4%	11.3%	0.6%	6,679.3	253.7	12/87
65	Anthem Electronics	6.7%	7.5%	7.3%	7.5%	196.9	5.0	12/87
66	GM Hughes Electronics	6.7%	6.1%	7.4%	6.7%	10,481.0	521.1	12/87
67	Cherry Electrical	6.6%	2.8%	10.4%	4.4%	194.6	7.4	2/88
68	Apollo Computer	6.3%	3.0%	9.6%	4.9%	553.7	21.7	12/87
69	CTS	6.3%	-16.0%	8.3%	-22.8%	261.1	10.5	12/87
70	Veeco Instruments	6.2%	0.3%	9.2%	0.4%	195.6	-9.2	9/87
71	Prime Computer	6.1%	10.3%	12.9%	10.7%	960.9	64.8	12/87
72	Maxtor	6.0%	9.8%	11.9%	20.4%	271.2	14.1	3/88
73	National Semiconductor	5.9%	-2.5%	6.2%	-2.8%	2,469.7	62.7	5/88
74	Pioneer-Standard Electronics	5.8%	2.2%	15.4%	6.3%	254.6	5.2	3/88
75	Analog Devices	5.6%	7.6%	6.1%	8.7%	370.4	18.7	10/87
76	Recognition Equipment	5.6%	6.0%	8.4%	9.1%	264.7	11.2	10/87
77	ISC Systems	5.4%	12.0%	6.5%	14.7%	168.5	6.5	6/87
78	Litton Industries	5.3%	2.8%	13.1%	7.0%	4,419.7	138.1	7/87
79	Micom Systems	5.3%	1.4%	5.6%	1.5%	223.4	9.8	3/88
80	DSC Communications	5.1%	3.3%	6.9%	5.5%	312.4	14.6	12/87
81	SCI Systems	5.0%	7.0%	12.0%	12.0%	552.9	16.0	6/87
82	Augat	4.8%	-3.6%	5.4%	-4.4%	313.2	11.5	12/87
83	AVX	4.8%	-1.5%	8.5%	-2.0%	271.9	15.8	12/87
84	Oak Industries	4.8%	-30.6%	7.2%	-50.7%	182.2	5.7	12/87
85	Wyle Laboratories	4.3%	4.8%	6.5%	5.3%	368.0	5.8	1/88
86	Cubic	4.1%	0.7%	7.1%	1.0%	361.8	7.9	9/87
87	Varian Associates	4.1%	-3.0%	4.9%	-3.6%	982.8	21.4	9/87
88	BRIntec	4.0%	8.6%	10.0%	21.5%	293.7	5.9	12/87
89	VLSI Technology	3.4%	0.0%	5.7%	0.0%	172.0	8.1	12/87
90	Mark IV Industries	3.1%	3.9%	18.4%	25.3%	403.0	17.0	2/88
91	Wang Laboratories	3.1%	2.3%	4.8%	3.5%	2,836.7	70.7	6/87
92	Cipher Data Products	3.1%	5.4%	3.1%	5.4%	178.2	4.3	6/87
93	Gould	3.0%	3.6%	5.2%	6.2%	933.4	25.0	12/87
94	Avnet	2.6%	3.1%	3.5%	3.7%	1,547.1	22.8	6/87
95	Sun Electric	2.5%	3.4%	4.1%	27.5%	203.9	3.3	10/87
96	Andrew	2.2%	5.7%	2.5%	6.6%	223.2	3.8	9/87
97	LSI Logic	2.2%	1.1%	3.5%	1.5%	262.1	10.7	12/87
98	John Fluke	1.7%	8.5%	1.9%	9.8%	206.3	2.0	9/87
99	Control Data	1.7%	-20.0%	2.4%	-31.0%	3,366.5	25.0	12/87
100	Singer	1.5%	6.2%	3.7%	9.6%	1,902.7	23.4	12/87

Source: ELECTRONIC BUSINESS

Well! Look who paid no '87 taxes to Uncle Sam!

IBM, AMD, Xerox and others actually got rebates from the IRS in 1987. But possible tax hikes and more complex rules spell headaches for high tech

They must have great tax attorneys. Last year, big wheels in the U.S. electronics industry — companies like Data General Corp., IBM and Zenith Electronics Corp. — not only paid no federal tax, but many received tax credits.

Part of the reason is that U.S. electronics firms are more reliant on foreign operations than ever before; for example, in 1987, almost all of IBM's tax provision went to governments overseas. In part, too, the rebates are thanks to deferred investment tax credits. But with the repeal of the investment tax relief laws, that's a situation that may not be repeated.

Indeed, increased tax-law complexities and the threat of budget-balancer tax increases from a new White House administration do not bode well for high tech. On average, electronics-industry taxes were already higher in 1987 than in the previous year.

The dust has yet to settle on the Tax Reform Act of 1986. With a technical corrections bill being hammered out in Congress and the Internal Revenue Service trying to interpret the bill, corporate America is doing its best to get a handle on what is going on. It is not an easy task.

According to the ELECTRONIC BUSINESS annual survey of the top electronics industry taxpayers for 1987, the figures are superficially encouraging (see chart). For the 130 companies on the list, the average effective tax rate dropped from 42.9% in 1986 to 39.4% in 1987. For the top 20 companies, all but six posted a decline in their effective tax rates between 1986 and 1987. Only those companies from the ELECTRONIC BUSINESS 200 [July 15, 1988] that derive at least 70% of their total revenue from electronics qualified for inclusion on this list.

BY BRUCE C.P. RAYNER
and LINDA STALLMANN

Not surprisingly, IBM was again the top electronics taxpayer, accounting for 39% of total 1987 tax provisions of the companies listed. In fact, IBM set more aside for taxes in 1987 than the next top 12 companies combined — but not a cent of that money is going to Uncle Sam. The Feds wound up giving Big Blue a credit of \$113 million on its U.S. earnings of nearly \$4 billion based on deferred investment tax credits of \$141 million. Among the other 23 companies that came off clean with Uncle Sam were seventh-ranked Xerox Corp. and 37th-placed Perkin-Elmer Corp.

On the surface, the electronics industry has survived tax reform with minimal damage. True, the investment tax credit is no longer around,

nor is the capital gains differential. But a watered down version of the research and experimentation (R&E) tax credit, a big perk for high tech, looks to be a shoo-in for a two-year extension. It is up to the congressional Joint Committee on Taxation to work out the details, but most high-tech Hill watchers are confident the R&E credit will survive.

However, taking a closer look behind glossy annual reports and industry aggregates reveals an unsettling picture of the aftermath of reform. For example, if IBM is taken off the ELECTRONIC BUSINESS top taxpayers list, the remaining 129 companies ended up by posting an increase in their average effective tax rate last year, from 35.7% in 1986 to 39.6% in 1987. Again, excluding IBM, the total tax burden increased by 67.8% between 1986 and 1987, while net income rose by 63%.

Too complex

Besides higher rates and more taxes, electronics companies insist the new law has added considerably to the administrative burden of doing business. "If you talk to the typical company chiefs, they will say that the complexity due to the transition is what strikes them the most, not that they are paying more or less in taxes as a corporation," comments James LeMunyon, a lobbyist for the American Electronics Association (AEA) in Washington, D.C.

Even the accountants are concerned. Reform has complicated their work to the point where they cannot function without a computer. The biggest culprits, they say, are the alternative minimum tax (AMT) and the new uniform capitalization rules. "You have to raise the question of whether or not our tax system has gone a little bit haywire if the only way you can get your tax compliance

Rebates all around...

Federal tax credit for fiscal 1987
(\$ millions)

IBM	\$113.00
Perkin-Elmer	25.79
Teradyne	11.50
Zenith	11.00
Data General	9.11
Decision Industries	6.29
Xerox	6.00
Cipher Data	3.49
Esterline	3.31
Andrew	2.48
Micropolis	1.35
Sun Electric	1.22
RFIntec	0.81
Coherent	0.38
Applied Materials	0.31
Cherry Electrical	0.25
AMD	0.09

Sources: ELECTRONIC BUSINESS
and company reports



done is by buying a computer program," comments Kent Schreiner, a principal in the Boston office of Ernst & Whinney, a Big Eight accounting firm.

Some high-tech tax experts warn that tax reform goes further than just higher bookkeeping costs. They complain that start-up activity is being hampered by the restrictions on net operating loss (NOL) carryforwards and a higher capital gains tax. Also, defense contractors are being squeezed as a result of the repeal of the completed contracts method of accounting, which used to allow a contractor to defer taxes. Without it, productivity, research and development and capital investment will drop significantly, defense industry leaders say. "It is like taxing a farmer as soon as he plants his crop," complains Don Fuqua, president of the Aerospace Industries Association. The drought in the defense business does not help either.

Tax reform is making itself felt on the international front too. Reform

has lowered the U.S. tax rate below that of most trading partners, thus making international tax planning more critical for American companies that operate overseas. Because of the new rules, the complexity of international tax planning has also increased significantly. As a result, Big Eight accountants are recommending their clients reevaluate all their offshore operations.

Nowhere is this more evident than in electronics. For the ELECTRONIC BUSINESS top taxpayers, over 60% of 1987's taxes went to foreign governments, reflecting a significant reliance on offshore manufacturing and international markets. In the case of top taxpayer IBM, the foreign tax burden is even more pronounced. In 1987, 99.6% of IBM's tax provision went to foreign governments, even though only 54% of its products were sold overseas. This resulted in an effective foreign tax rate of 58.7% last year for Big Blue.

Despite the rhetoric from Washington about rebuilding America's in-

ternational competitive position, tax reform has made it more difficult for U.S.-based high-tech companies to export, claims Mark Singer, a tax partner at the accounting firm of Price Waterhouse in San Jose. "I think it is almost a policy question that at a time when we are concerned with our balance of trade with other countries, some of the changes have discouraged exports from an economic standpoint," he says.

How to stifle foreign business

In particular, Singer points to limitations on foreign tax credits as an example of how tax reform is stifling foreign business. Also, various changes in the tax laws, such as the "super royalty," mean that operations in low-tax countries such as Ireland or Switzerland have become less attractive. In essence, the super royalty charges a license fee on technology transferred offshore based on the market value of the product that is being manufactured, a rate higher than companies previously had to pay.

"Super royalty is most likely bad tax policy," says Howard Slayen, a tax partner-in-charge at the San Jose/Menlo Park office of Coopers & Lybrand, a Big Eight accounting firm. Slayen complains that in its zeal to close a loophole, "Congress went too far in coming up with a system that is not rational and not in conformity with accepted international standards."

In an unrelated foreign tax issue, the Internal Revenue Service is changing its interpretation of how a company can pass title across international borders. Based on its interpretation of section 863(b) of the tax code, the IRS used to let companies transfer title outside the United States and use the foreign source income toward a tax credit on U.S. taxes. But now, the IRS is making it harder to claim that credit.

Given such a climate, most tax experts suggest close scrutiny of foreign operations as the first step toward more effective tax planning. However, because of the November election and the expected tax changes in 1989, the planning horizon should be kept short — no more than two or three years, the pencil pushers say.

Another possibility, says Ernst & Whinney's Schreiner, is for electronics companies to change the capitalization ratios in their foreign subsidi-

aries. A higher debt burden, he says, could be a way to save money. For instance, instead of issuing shares in the foreign company, make a loan from the U.S. parent. In this way, the subsidiary can take a tax deduction while the U.S. parent company pays a relatively lower tax rate in-country on the interest income it earns.

Back on the domestic front, a new Financial Accounting Standards Board (FASB) statement No. 96 is changing the way all corporations have to report their income taxes. The new rule is mandated to take effect on Dec. 15 of this year. Initially, FASB 96 had the support of the accounting community, but because of its complexity, many tax accountants have changed their opinion.

"There will be many high-tech companies whose earnings will be adversely affected by FASB 96, which, as a result, will be reporting higher income expense and lower earnings to the public," says Singer at Price Waterhouse. The lower earnings might prompt some companies to change their corporate planning strategies, he speculates.

In essence, the 100-page FASB statement forces corporations to report their deferred taxes to take into account any current or subsequent changes in tax rates. The reason is so that the balance sheet better reflects the true liability of taxes due, says an FASB spokesperson. But many accountants contend that the new ruling will create wild swings in the tax expense and on the bottom line. And with tax rates changing every few years, the fluctuations in the financial reports could distort the public's perception of the health of the company. According to Ernst & Whinney's Schreiner, FASB 96 will also affect how foreign taxes are reported, thus creating even more of a whiplash effect in company figures.

The next surprise

The whiplash will most likely be compounded. Corporate America's next surprise will be what the new president will do to reform the reform. Watch for the National Economic Committee's report, due out early next year, to set the stage for tax policy changes. Pundits expect the report will condone tax increases — possibly corporate rate increases — as one way to get a handle on the 1990 federal budget deficit.

The bottom line on tax reform

Corporations have been footing more of the tax bill...

Percentage of income and profit taxes collected by the IRS



...and tax reform isn't helping

Estimated additional tax revenue paid by U.S. corporations as a result of the Tax Reform Act of 1986 (\$ billions)



But for now, the best that tax planners can do is guess at what the tax laws will be like next year. Besides some vague generalities, neither presidential candidate is committing to concrete fiscal strategy. Vice President George Bush has said he would reinstate the 15% capital gains tax, but little else has been heard from either candidate.

Adding to the political uncertainty is the future chairmanship of the powerful Senate Finance Committee that is currently held by Texas senator and Democratic vice-presidential

hopeful Lloyd Bentsen. If Massachusetts Gov. Michael Dukakis wins the presidential election, the chair will probably go to ranking Democrat Spark Matsunaga of Hawaii.

Whoever gets elected, the critical task ahead will be how to handle the federal budget deficit. Economists agree it will involve both raising taxes and lowering spending. David Wyss, chief financial economist at Data Resources Inc., expects some increase in "sin taxes" on tobacco and alcohol, but does not see much chance for a proposed value-added tax or even any significant change in the corporate tax rate. However, if Congress finds itself in dire need, "the corporate rate is one they are likely to come after," he says. Wyss also speculates on a drop in the capital gains tax to around 20%, down from its current 28% level, coupled with a leveling off of the top personal tax rates to around 32%.

It is still too early to have hard and fast numbers on the economic effects of tax reform. Even when the figures become available, it will be difficult to isolate those changes caused by tax reform. But one of the critical gauges that economists are watching is the rate of capital investment. Some doomsayers claim that tax reform has crippled manufacturing investment, while others point to healthy investment growth in early 1988 as proof that investment decisions are being made more on economic grounds than on the basis of favorable tax breaks. The reality is probably a combination of the two.

A study conducted by Gordon Richards, an economist at the National Association of Manufacturers in Washington D.C., estimates that \$30 billion in gross national product growth has been wiped out by tax reform. The main reason for the drop was the one time increase in the cost of capital as a result of the repeal of the investment tax credit, he says.

But for the electronics industry, there have been mitigating circumstances that have helped to dampen the negative effects of tax reform, says Richards. The fall in the value of the U.S. dollar has spurred U.S. sales of computers and data-processing equipment, while the steady drop in prices of electronic equipment has offset the repeal of the ITC. For the present then, high tech should count itself lucky. □

Taxes paid by top electronics companies

Rank	Company	Total income tax provision (benefit) (\$ millions)		Percentage change from 1986	1987 income tax provision (benefit) (\$ millions)		
		1987	1986		Federal	State and local	Foreign
1	IBM	\$3,351.0	\$3,600.0	-6.9%	(\$113.0)	\$128.0	\$3,336.0
2	DEC	551.5	240.1	129.7%	297.1	48.7	205.8
3	GM Hughes Electronics	378.1	366.1	3.3%	319.3	62.3	(3.5)
4	Unisys	369.5	(48.4)	NM	186.6	24.1	158.8
5	NCR	343.1	283.2	21.2%	95.4	10.4	237.4
6	Hewlett-Packard	318.0	264.0	20.5%	82.0	37.0	199.0
7	Xerox	262.0	112.0	133.9%	(6.0)	6.0	262.0
8	Tandy	213.6	186.4	14.6%	193.5	17.7	2.4
9	Apple Computer	192.9	155.8	23.8%	146.2	27.9	18.9
10	AMP	180.8	129.7	39.4%	57.1	19.1	104.6
11	Honeywell	158.2	26.9	488.1%	79.0	14.7	64.5
12	Texas Instruments	157.8	59.0	167.5%	101.0	NA	57.0
13	Amdahl	125.0	29.5	323.7%	92.9	17.1	15.0
14	Intel	112.3	8.7	1,198.8%	67.3	14.9	30.1
15	Litton Industries	110.8	56.9	94.8%	86.5	15.3	9.1
16	Motorola	108.0	71.0	52.1%	65.0	17.0	26.0
17	Pitney Bowes	95.7	93.3	2.5%	51.3	13.7	30.7
18	Compaq Computer	92.7	31.9	190.6%	72.0	3.3	17.4
19	Cray Research	85.3	100.4	-15.0%	70.0	10.1	5.3
20	Tandem Computers	79.3	50.7	56.4%	45.0	12.4	21.9
21	Tektronix	51.9	3.0	1,628.3%	12.9	2.4	36.6
22	Microsoft	49.5	26.7	85.0%	NA	NA	NA
23	Seagate Technology	46.0	1.6	2,782.1%	35.6	10.4	0.0
24	Intergraph	45.9	53.1	-13.6%	32.4	3.4	10.1
25	General Instrument	41.7	11.2	272.3%	26.9	4.5	10.2
26	Loral	41.3	41.3	0.0%	37.0	4.3	0.0
27	Harris	37.9	1.1	3,323.3%	28.3	6.7	2.9
28	E-Systems	35.8	47.8	-25.1%	35.8	NA	NA
29	Medtronic	34.9	34.9	0.0%	17.9	4.6	12.4
30	Ashton-Tate	33.9	28.1	20.8%	21.5	6.7	5.7
31	Sun Microsystems	32.8	9.0	263.9%	17.4	5.8	9.7
32	Control Data	32.5	10.0	225.0%	7.4	3.5	21.6
33	Molex	32.0	21.3	50.3%	1.8	0.8	29.4
34	Lotus Development	30.9	22.7	35.8%	21.7	1.7	7.5
35	Atari	30.7	22.2	38.3%	25.4	0.1	5.1
36	Computer Associates	30.6	14.7	107.8%	18.2	2.5	9.9
37	Perkin-Elmer	24.8	39.7	-37.4%	(25.8)	1.4	49.3
38	Scientific-Atlanta	24.3	(6.4)	NM	20.9	1.2	2.2
39	Avnet	23.8	18.4	29.3%	20.0	3.9	0.0
40	Gould	23.2	22.5	3.1%	5.6	1.1	16.5
41	Cullinet Software	22.4	11.1	101.2%	21.6	0.7	0.1
42	Prime Computer	21.6	15.6	38.0%	14.1	1.3	6.2
43	National Semiconductor	19.5	14.5	34.9%	18.2	2.2	(0.9)
44	Diebold	19.4	21.8	-11.1%	16.8	2.6	— ¹
45	Wang Laboratories	19.0	5.0	280.0%	0.3	0.5	18.2

¹ Foreign and federal taxes reported together

NM = Not meaningful

NA = Not available

STRATEGIES

FINANCE

Effective tax rate		Fiscal 1987 revenue and income (\$ millions)			Foreign revenue as a percentage of total revenue	Fiscal year ended	1987 ELECTRONIC BUSINESS 200 rank	Location
1987	1986	Total revenue	Income before taxes	Net income*				
38.9%	42.9%	54,217.0	8,609.0	5,258.0	54.0%	12/87	1	Armonk, N.Y.
32.7%	28.0%	9,389.4	1,689.0	1,137.4	47.0%	6/87	4	Maynard, Mass.
42.0%	45.1%	10,481.0	899.2	521.1	11.6%	12/87	3	Detroit, Mich.
39.0%	-52.7%	9,712.9	947.5	578.0	43.6%	12/87	5	Detroit, Mich.
45.0%	45.7%	5,640.7	762.4	419.3	54.6%	12/87	11	Dayton, Ohio
33.1%	33.8%	8,090.0	962.0	644.0	49.0%	10/87	8	Palo Alto, Calif.
31.2%	16.6%	10,320.0	840.0	578.0	44.9%	12/87	7	Stamford, Conn.
46.6%	48.2%	3,452.2	458.8	242.3	1.6%	6/87	17	Ft. Worth, Texas
47.0%	50.3%	2,661.1	410.4	217.5	27.1%	9/87	22	Cupertino, Calif.
42.0%	44.1%	2,317.8	430.5	249.7	52.3%	12/87	34	Harrisburg, Pa.
38.4%	67.6%	6,679.3	411.9	253.7	20.6%	12/87	10	Minneapolis, Minn.
38.1%	59.8%	5,594.5	414.7	256.9	31.5%	12/87	12	Dallas, Texas
46.8%	42.9%	1,505.2	267.0	142.0	44.3%	12/87	41	Sunnyvale, Calif.
39.0%	5.0%	1,907.1	287.9	175.5	38.8%	12/87	35	Santa Clara, Calif.
44.5%	44.4%	4,419.7	249.0	138.1	22.7%	7/87	20	Beverly Hills, Calif.
26.0%	26.8%	6,707.0	416.0	308.0	43.8%	12/87	9	Schaumburg, Ill.
41.9%	46.3%	2,250.5	228.7	199.4	19.5%	12/87	31	Stamford, Conn.
40.7%	41.7%	1,224.1	228.1	136.3	26.0%	12/87	47	Houston, Texas
36.7%	44.6%	687.3	232.4	147.1	37.0%	12/87	68	Minneapolis, Minn.
42.9%	44.3%	1,035.5	184.9	105.6	44.4%	9/87	52	Cupertino, Calif.
50.3%	7.1%	1,395.9	103.0	51.2	42.2%	5/87	44	Beaverton, Ore.
40.8%	40.5%	345.9	121.3	71.9	42.3%	6/87	86	Redmond, Wash.
24.8%	4.4%	958.1	185.7	139.7	43.6%	6/87	53	Scotts Valley, Calif.
39.6%	43.0%	641.1	115.8	69.9	36.9%	12/87	71	Huntsville, Ala.
38.6%	37.7%	787.9	107.9	18.5	16.2%	2/88	50	New York, N.Y.
41.8%	41.8%	690.0	98.7	57.5	6.2%	3/87	61	New York, N.Y.
31.0%	1.8%	2,079.0	122.4	84.5	14.7%	6/87	30	Melbourne, Fla.
37.2%	43.7%	1,227.2	96.2	60.4	6.6%	12/87	54	Dallas, Texas
32.1%	32.1%	502.0	108.7	73.8	41.5%	4/87	79	Minneapolis, Minn.
44.0%	48.2%	267.3	77.0	43.1	30.3%	1/88	129	Torrance, Calif.
47.5%	43.0%	537.5	69.1	36.3	32.0%	6/87	65	Mountain View, Calif.
56.6%	3.6%	3,366.5	57.4	25.0	20.0%	12/87	26	Minneapolis, Minn.
42.2%	39.7%	386.8	75.8	43.4	68.4%	6/87	90	Lisle, Ill.
30.0%	32.0%	395.6	102.9	72.0	52.3%	12/87	94	Cambridge, Mass.
41.0%	47.0%	493.2	74.8	44.2	45.9%	12/87	82	Sunnyvale, Calif.
45.6%	44.3%	309.3	67.1	36.5	48.7%	3/87	74	Garden City, N.Y.
372.6%	35.4%	1,333.6	6.7	-18.2	46.2%	7/87	46	Norwalk, Conn.
50.0%	-41.0%	495.3	48.5	24.3	15.0%	6/87	81	Atlanta, Ga.
51.1%	43.6%	1,547.1	46.6	22.8	0.0%	6/87	42	New York, N.Y.
48.1%	39.4%	933.4	48.2	25.0	38.0%	12/87	60	Rolling Meadows, Ill.
44.7%	46.0%	174.9	-50.0	-27.6	26.4%	4/87	153	Westwood, Mass.
25.0%	25.0%	960.9	86.4	64.8	48.0%	12/87	58	Natick, Mass.
209.7%	10.8%	1,867.9	-9.3	-28.8	42.1%	5/87	36	Santa Clara, Calif.
35.1%	38.4%	439.1	55.1	35.8	7.0%	12/87	101	Canton, Ohio
36.8%	8.9%	2,836.7	-51.7	70.7	40.1%	6/87	21	Lowell, Mass.

Source: ELECTRONIC BUSINESS

* Net income or loss before extraordinary items and discontinued operations

(Continued)

Taxes paid by top electronics companies

Rank	Company	Total income tax provision (benefit) (\$ millions)		Percentage change from 1986	1987 income tax provision (benefit) (\$ millions)		
		1987	1986		Federal	State and local	Foreign
46	Dynatech	\$18.5	\$18.5	0.0%	\$13.1	\$2.0	\$3.4
47	Digital Communications	17.6	14.0	25.9%	15.6	2.0	0.0
48	Western Digital	14.7	7.2	104.4%	6.8	4.0	4.0
49	Maxtor	14.6	14.6	0.0%	10.6	3.7	0.3
50	MAI Basic Four	14.6	11.3	29.1%	4.5	1.3	8.7
51	Gerber Scientific	13.3	13.3	0.0%	11.2	1.5	0.6
52	Xidex	12.8	20.2	-36.6%	10.2	2.3	0.4
53	Apollo Computer	12.7	6.0	113.8%	4.2	1.9	6.7
54	Oracle Systems	12.3	4.6	168.1%	9.1	2.2	0.9
55	Ultimate	12.2	12.2	0.0%	9.4	1.8	1.0
56	Stratus Computer	12.2	10.0	22.4%	8.1	2.2	1.9
57	Bolt Beranek and Newman	11.9	8.4	41.4%	10.9	1.1	NA
58	Mentor Graphics	11.4	5.5	105.9%	5.0	0.5	6.0
59	Wyse Technology	11.3	7.9	43.5%	9.1	2.1	0.2
60	Watkins-Johnson	11.0	12.7	-14.1%	10.9	0.0	0.0
61	Measurex	10.7	9.8	9.5%	4.6	0.9	5.2
62	Mark IV Industries	10.7	8.4	27.5%	9.6	— ²	1.1
63	Varian Associates	10.5	(25.3)	NM	3.5	1.3	5.7
64	AVX	10.5	(1.3)	NM	8.9	0.9	0.6
65	ADC Telecommunications	10.2	9.0	13.2%	9.2	1.0	0.0
66	Emerson Radio	9.4	9.4	0.0%	5.2	0.7	3.6
67	Micropolis	9.1	14.1	-35.8%	(1.3)	3.0	7.5
68	AST Research	8.7	22.1	-60.7%	4.7	1.5	2.4
69	Genicom	8.6	7.4	16.7%	5.2	1.0	2.4
70	Avantek	8.3	13.3	-37.3%	6.8	1.5	0.0
71	Veeco Instruments	7.9	-0.2	3,282.0%	1.1	(0.3)	7.1
72	Recognition Equipment	7.5	6.0	24.8%	2.1	— ²	5.4
73	LSI Logic	7.0	4.1	70.8%	2.3	1.3	3.4
74	Augat	7.0	(3.8)	NM	2.9	0.9	3.2
75	Analog Devices	6.9	8.7	-20.2%	0.2	0.4	6.3
76	Inmac	6.9	4.4	55.4%	3.8	0.8	2.3
77	Dynascan	6.6	6.0	10.6%	6.6	0.0	0.0
78	Altos Computer	6.1	11.2	-45.5%	4.2	1.4	0.6
79	Logicon	6.1	6.1	0.0%	5.1	1.0	0.0
80	ISC Systems	6.0	9.9	-39.1%	5.3	0.8	NA
81	Marshall Industries	5.9	11.0	-46.8%	4.8	1.1	0.0
82	Storage Technology	5.6	17.7	-68.4%	2.7	(0.1)	3.0
83	Compugraphic	5.4	1.8	196.2%	NA	NA	NA
84	Cubic	5.2	(0.3)	NM	4.1	1.1	0.0
85	MiniScribe	5.1	2.8	82.1%	3.0	0.9	1.2
86	Wyle Laboratories	4.7	2.7	75.6%	3.8	0.9	0.0
87	Datapoint	4.2	8.0	-47.5%	1.3	0.0	2.9
88	Fluke	4.2	4.8	-12.4%	3.6	NA	0.5
89	Anthem Electronics	4.1	2.9	40.8%	3.3	0.8	0.0
90	Coherent	4.1	3.4	19.8%	(0.4)	0.3	4.2

¹ State taxes included with federal

NM = Not meaningful

NA = Not available

FINANCE

Effective tax rate		Fiscal 1987 revenue and income (\$ millions)			Foreign revenue as a percentage of total revenue	Fiscal year ended	1987 ELECTRONIC BUSINESS 200 rank	Location
1987	1986	Total revenue	Income before taxes	Net income*				
44.3%	44.3%	\$304.7	\$41.7	\$23.2	25.4%	3/87	102	Burlington, Mass.
39.4%	40.4%	181.4	44.6	27.0	19.0%	6/87	160	Alpharetta, Ga.
25.6%	26.0%	462.5	57.5	42.8	36.9%	6/87	76	Irvine, Calif.
39.4%	39.4%	175.3	36.9	22.4	16.0%	3/87	142	San Jose, Calif.
38.9%	40.0%	321.0	37.4	22.8	64.1%	9/87	106	Tustin, Calif.
38.9%	38.9%	223.9	34.2	21.1	47.0%	4/87	138	Hartford, Conn.
33.5%	38.5%	572.8	38.2	-44.5	29.9%	6/87	85	Sunnyvale, Calif.
37.0%	39.0%	553.7	34.4	21.7	51.8%	12/87	78	Chelmsford, Mass.
44.0%	43.7%	131.3	27.9	15.6	46.8%	5/87	172	Belmont, Calif.
47.0%	47.0%	172.9	26.0	13.8	23.4%	4/87	159	East Hanover, N.J.
38.7%	42.5%	184.2	31.6	19.4	29.2%	12/87	174	Marlboro, Mass.
305.2%	42.7%	233.8	3.9	-8.0	0.0%	6/87	122	Cambridge, Mass.
36.0%	33.5%	221.8	31.7	20.3	45.9%	12/87	151	Beaverton, Ore.
38.5%	38.6%	260.0	29.5	18.1	20.2%	3/87	95	San Jose, Calif.
38.1%	42.5%	264.3	28.7	17.1	19.0%	12/87	133	Palo Alto, Calif.
28.6%	31.7%	227.4	37.5	26.8	59.4%	11/87	149	Cupertino, Calif.
38.6%	45.1%	403.0	27.8	17.0	14.6%	2/88	113	Amherst, N.Y.
33.0%	-63.0%	982.8	31.9	21.4	23.6%	9/87	56	Palo Alto, Calif.
39.9%	-29.2%	271.9	26.3	15.8	43.0%	12/87	123	Great Neck, N.Y.
40.0%	42.9%	166.9	25.4	15.3	12.4%	10/87	178	Minneapolis, Minn.
26.2%	26.2%	810.1	36.1	26.6	0.0%	3/87	63	Secaucus, N.J.
25.0%	43.7%	288.3	36.3	27.2	69.7%	12/87	121	Chatsworth, Calif.
40.0%	44.9%	206.0	21.7	13.0	19.6%	6/87	119	Irvine, Calif.
45.1%	46.2%	302.2	19.2	12.6	32.0%	12/87	116	Waynesboro, Va.
41.8%	45.2%	213.7	19.9	11.6	13.0%	12/87	152	Santa Clara, Calif.
41.9%	13.0%	195.6	18.8	9.2	46.1%	9/87	156	Melville, N.Y.
40.0%	40.0%	264.7	18.7	11.2	49.1%	10/87	126	Irving, Texas
40.7%	48.2%	262.1	17.3	10.7	14.6%	12/87	134	Milpitas, Calif.
37.9%	-30.3%	313.2	18.4	11.5	18.0%	12/87	111	Mansfield, Mass.
27.0%	27.0%	370.4	25.6	18.7	46.4%	10/87	97	Norwood, Mass.
47.0%	46.8%	165.4	14.6	7.7	59.2%	7/87	181	Santa Clara, Calif.
54.4%	49.5%	191.6	12.1	6.6	2.1%	12/87	168	Chicago, Ill.
38.8%	35.7%	153.9	15.8	9.7	42.0%	6/87	188	San Jose, Calif.
50.2%	50.2%	204.8	12.2	6.1	0.0%	3/87	155	Torrance, Calif.
48.0%	41.7%	168.5	12.6	6.5	0.0%	6/87	176	Spokane, Wash.
51.3%	51.2%	286.6	11.4	5.1	0.0%	5/87	105	El Monte, Calif.
22.8%	51.3%	750.0	24.6	19.0	26.4%	12/87	66	Louisville, Colo.
34.8%	35.0%	367.1	15.5	10.1	28.9%	12/87		Wilmington, Mass.
39.8%	-33.5%	361.8	13.2	7.9	0.0%	9/87	114	San Diego, Calif.
15.2%	12.1%	362.5	33.2	28.1	36.1%	12/87	99	Longmont, Colo.
45.0%	38.5%	368.0	10.5	5.8	0.0%	1/88	132	El Segundo, Calif.
7.7%	NM	312.1	-54.3	-58.5	79.2%	7/87	110	San Antonio, Texas
67.5%	28.1%	206.3	6.2	2.0	40.5%	9/87	157	Everett, Wash.
45.2%	52.0%	196.9	9.1	5.0	0.0%	12/87	162	San Jose, Calif.
136.9%	NM	159.0	3.0	-1.1	46.4%	9/87	185	Palo Alto, Calif.

Source: ELECTRONIC BUSINESS

* Net income or loss before extraordinary items and discontinued operations

(Continued)

Taxes paid by top electronics companies

Rank	Company	Total income tax provision (benefit) (\$ millions)		Percentage change from 1986	1987 income tax provision (benefit) (\$ millions)		
		1987	1986		Federal	State and local	Foreign
91	Singer	\$4.0	\$6.8	-41.2%	\$1.3	\$0.0	\$2.7
92	SCI Systems	4.0	8.5	-52.9%	NA	NA	NA
93	CTS	3.9	3.5	14.1%	2.4	0.6	1.0
94	Applied Magnetics	3.9	0.8	415.3%	2.0	1.1	0.8
95	Aydin	3.8	5.2	-27.7%	3.0	0.8	0.0
96	Micom Systems	3.7	3.7	0.0%	1.0	1.7	1.1
97	Intelligent Systems	3.7	1.5	151.0%	3.0	0.7	0.0
98	TIE/communications	3.6	3.1	16.2%	2.7	0.7	0.2
99	Westmark International	3.4	(10.9)	NM	2.5	0.7	0.3
100	Pioneer-Standard	3.4	1.3	162.1%	2.8	0.6	0.0
101	DSC Communications	3.1	2.4	27.9%	0.2	2.6	0.3
102	Cherry Electrical	3.0	(1.5)	NM	(0.3)	— ²	3.3
103	Tandon	2.8	2.3	19.1%	2.2	— ²	0.5
104	Sprague Technologies	2.7	1.8	50.0%	0.5	0.2	2.0
105	Computer Consoles	2.6	2.0	29.2%	0.2	2.3	0.1
106	BRIntec	2.5	6.8	-63.3%	(0.8)	0.2	3.2
107	Advanced Micro Devices	2.5	(9.1)	NM	(0.1)	1.6	1.0
108	Dataproducts	2.1	2.1	0.0%	0.1	0.7	1.3
109	Quantum	2.1	9.6	-78.4%	0.7	1.4	0.0
110	Paradyne	1.7	0.8	98.0%	0.0	0.4	1.3
111	Diasonics	1.6	1.3	26.2%	0.2	0.1	1.3
112	VLSI Technology	1.3	0.3	389.6%	0.2	1.0	0.1
113	General DataComm	1.3	(2.4)	NM	0.2	0.3	0.8
114	Andrew	1.2	6.8	-82.5%	(2.5)	0.6	3.1
115	GenRad	1.1	0.8	43.8%	0.0	0.1	1.0
116	Oak Industries	0.8	2.7	-70.6%	0.1	0.1	0.6
117	LTX	0.7	(6.2)	NM	0.0	0.0	0.7
118	International Rectifier	0.6	0.7	-9.8%	0.0	0.5	0.1
119	Kollmorgen	0.6	(2.7)	NM	0.0	0.0	0.6
120	Sun Electric	0.5	2.3	-78.2%	(1.2)	0.0	1.7
121	Savin	0.3	0.0	NM	NA	NA	NA
122	Applied Materials	0.2	0.9	-73.1%	(0.3)	0.3	0.2
123	Arrow Electronics	0.0	0.0	0.0%	0.0	0.0	0.0
124	Esterline	(2.6)	1.4	NM	(3.3)	0.6	0.1
125	Cipher Data Products	(3.5)	3.4	NM	(3.5)	0.2	0.9
126	Data General	(4.0)	4.9	NM	(9.1)	(1.0)	6.1
127	Decision Industries	(6.0)	3.4	NM	(6.3)	0.2	0.1
128	Zenith Electronics	(9.8)	(10.2)	NM	(11.0)	(1.1)	2.3
129	Teradyne	(11.7)	(2.9)	NM	(11.5)	(0.3)	0.1
130	M/A-COM	(19.6)	(16.5)	NM	NA	NA	NA
Total		\$8,541.2	\$6,694.3	27.6%	\$2,649.9	\$641.1	\$5,192.3

² State taxes included with federal

NM = Not meaningful

NA = Not available

FINANCE

Effective tax rate		Fiscal 1987 revenue and income (\$ millions)			Foreign revenue as a percentage of total revenue	Fiscal year ended	1987 ELECTRONIC BUSINESS 200 rank	Location
1987	1986	Total revenue	Income before taxes	Net income*				
14.6%	10.4%	\$1,902.7	\$27.4	\$23.4	0.0%	12/87	40	Stamford, Conn.
20.0%	38.1%	552.9	20.0	16.0	24.8%	6/87	73	Huntsville, Ala.
27.3%	14.9%	261.1	14.4	10.5	19.7%	12/87	135	Elkhart, Ind.
21.6%	15.6%	211.9	18.1	14.2	46.5%	9/87	144	Goleta, Calif.
30.0%	42.8%	149.2	12.6	8.8	17.8%	12/87	199	Horsham, Pa.
23.3%	23.3%	196.7	15.9	12.2	10.0%	3/87	154	Simi Valley, Calif.
23.6%	61.8%	163.2	15.5	10.2	26.6%	12/87	189	Norcross, Ga.
48.4%	5.6%	250.2	-7.4	-11.1	30.3%	12/87	125	Shelton, Conn.
89.9%	-39.8%	291.9	-3.8	-7.2	28.0%	12/87	118	Seattle, Wash.
39.2%	40.9%	212.2	8.6	1.8	0.0%	3/88	143	Cleveland, Ohio
17.3%	17.8%	312.4	17.6	14.6	14.4%	12/87	112	Plano, Texas
52.6%	-38.8%	160.6	5.8	2.7	49.4%	2/87	190	Waukegan, Ill.
13.9%	3.8%	289.1	19.8	17.1	75.0%	12/87	120	Chatsworth, Calif.
42.9%	1.1%	437.3	6.3	3.6	38.2%	12/87	89	Greenwich, Conn.
21.3%	84.9%	148.4	12.2	9.6	21.4%	12/87	200	Waltham, Mass.
29.8%	36.8%	293.7	8.4	5.9	15.8%	12/87	150	Willimantic, Conn.
5.6%	8.8%	997.1	-45.1	-48.1	27.2%	12/87	57	Sunnyvale, Calif.
19.0%	19.0%	338.8	11.1	9.0	26.8%	3/87	107	Woodland Hills, Calif.
19.0%	30.1%	120.8	10.9	8.8	21.0%	3/87	177	Milpitas, Calif.
176.0%	2.2%	232.6	-0.9	-2.6	17.9%	12/87	146	Largo, Fla.
9.7%	8.0%	267.6	16.9	15.2	3.1%	12/87	127	South San Francisco, Calif.
14.0%	82.7%	172.0	9.4	8.1	22.1%	12/87	184	San Jose, Calif.
62.5%	NM	200.6	2.1	0.8	21.9%	9/87	166	Middlebury, Conn.
23.9%	41.8%	223.2	5.0	3.8	40.7%	9/87	147	Orlando Park, Ill.
34.7%	2.6%	193.8	3.2	2.1	40.4%	12/87	165	Concord, Mass.
12.3%	9.8%	182.2	6.5	5.7	14.4%	12/87	182	Rancho Bernardo, Calif.
11.8%	-32.9%	120.6	-6.0	-6.7	51.0%	7/87	198	Westwood, Mass.
3.6%	60.6%	151.8	-16.6	-17.2	50.1%	6/87	197	Los Angeles, Calif.
67.1%	-11.8%	301.0	0.9	0.3	11.4%	12/87	136	Hartford, Conn.
5.4%	62.4%	203.9	-9.2	3.3	30.0%	10/87	175	Crystal Lake, Ill.
72.8%	0.0%	356.3	0.4	0.1	10.8%	12/87	130	Stamford, Conn.
41.9%	42.0%	174.4	0.6	0.3	43.9%	10/87	158	Santa Clara, Calif.
0.0%	0.0%	562.4	-15.8	-15.8	0.0%	12/87	77	Farmingdale, N.Y.
-8.2%	59.9%	259.7	-31.9	-29.3	39.1%	10/87	167	Darien, Conn.
NM	31.9%	178.2	0.2	4.3	18.4%	6/87	183	San Diego, Calif.
-5.8%	35.0%	1,274.3	-69.9	-82.9	45.0%	9/87	45	Westboro, Mass.
-22.7%	30.7%	191.4	-26.4	-20.4	5.5%	11/87	169	Horsham, Pa.
33.9%	-50.5%	2,362.7	-28.9	-19.1	17.2%	12/87	29	Glenview, Ill.
-35.3%	NM	377.7	-33.2	-21.5	36.4%	12/87	98	Boston, Mass.
-40.1%	-42.6%	436.1	-48.9	-29.3	21.5%	9/87	88	Burlington, Mass.
39.4%	—	\$202,336.8	\$21,693.1	\$13,276.5				

Weighted
average

Source: ELECTRONIC BUSINESS

* Net income or loss before extraordinary
items and discontinued operations